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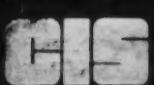

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# EXPORT ADMINISTRATION ISSUES

## HEARING

BEFORE THE

## COMMITTEE ON BANKING, HOUSING, AND URBAN AFFAIRS UNITED STATES SENATE

ONE HUNDRED FIRST CONGRESS

SECOND SESSION

ON

ROUNDTABLE DISCUSSION ON WHAT FEDERAL POLICY CAN DO TO PROMOTE OUR ENTREPRENEURIAL SKILL IN THIS COUNTRY AND BE ABLE TO PUT MORE INTO THE MARKETPLACE

MAY 21, 1990—WESTWOOD, MA

Printed for the use of the Committee on Banking, Housing, and Urban Affairs

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# EXPORT HEARING ECONOMIC ROUNDTABLE DISCUSSION

MONDAY, MAY 21, 1990

U.S. SENATE,
COMMITTEE ON BANKING, HOUSING, AND URBAN AFFAIRS,
*Westwood, MA.*

The hearing was convened, pursuant to notice, in Westwood, MA, Senator John Kerry presiding.

Senators present: John Kerry.

Also present: Mr. Donald J. White, Mr. Eugene Weisberger, Mr. James Vincent, Ms. Jackie Bonneau, Mr. Robert Tirman, Ms. Gail Sullivan, Esq., Mr. Griffith Resor III, Mr. Al Ferrara, Mr. Russell Newman, Mr. Mitchell Kertzman, Ms. Carlton Fiorina, Mr. Ron Bohlin, Mr. Mitchell Kapur, and Dean David Blackman.

## OPENING STATEMENT OF SENATOR KERRY

Senator KERRY. This hearing of the Senate Committee on Banking, Housing, and Urban Affairs will come to order—even though it isn't out of order. [Laughter.]

Welcome, everybody. Thank you for taking the time to join us here today. This is obviously a very unusual setting for an official hearing of the Banking Committee, or any committee for that matter, but we thought that, given the subject matter and also the importance of trying to bring home to people what we are really talking about, that it would be interesting to go to a location and get "real," in a way, sit here with the real stuff going on in back of us and talk about these matters.

To a certain degree that changes the flavor a little bit of the hearing. It is perhaps a little harder to say, gee, I am in an official U.S. Senate hearing, but in reality that is exactly what we are doing. And it is geared toward very specific legislation which is of enormous importance to everybody sitting around this table, and obviously of importance to people around this State and the country.

What I really want to talk about today, and what I want you to talk about in a different format from the standard hearing where we have just talking heads giving this prepared text, which most people should have read before the hearing started and which have usually been submitted in writing and which chews up so much time that you do not really get a dialogue—I am not a big fan of it, as you can tell—I thought it would be much better to sit where we can be spontaneous, candid, and lay a different kind of record for the legislation that we are trying to deal with.

What I want to focus on is what Federal policy can do and ought to do in order to promote not only high technology—although I want to talk about that—but the ability of our creative entrepreneurial skill in this country, and particularly in this State of Massachusetts, to be able to put us more into the marketplace.

How do we create more jobs?

How do we guarantee that we are going to be more competitive and produce more paychecks here in Massachusetts?

What is unique is that there is probably no place in the United States of America, with maybe one exception, where people could jump into their car in the morning and drive to a table like this and bring together the kinds of skills which all of you are bringing here. And in a way, your being here and your participation in this is its own testimony to the importance of this kind of effort.

Massachusetts has obviously thrived on high technology. The country has thrived on it. About three-quarters of the productivity increases of this Nation since World War II have come by virtue of productivity advances. It is clear to probably the most casual observer and unschooled lay person that the future is going to lie in our ability to be ahead of the curve in the next wave of products, whatever they are, and to act quickly and aggressively in the marketplace.

We chose to be here at General Instruments because this plant regrettably is a classic example of how we have an ability to be able to shoot ourselves in the foot and restrain growth. There are 80-or-so people working here. There could be a lot more. These folks had the ingenuity to develop a sonar mapping system which they wanted to sell to other countries, and because our Government decided—and perhaps rightfully at a certain point in time—that there were security interests involved at that time there were restraints on their ability to move into that marketplace.

The result of it was that other people developed systems as a consequence of that decision and then, lo and behold, the Government lifts the ban on the sale but winds up turning to other countries in order to buy rather than buying from us. So we take a double whammy. We cannot get into the other markets, and we wind up being shut out from our own market. And it took an act of Congress in order to say to the Defense Department, Whoa, we want you to buy from these folks because you are really stripping away our own competitive ability here in the process.

There is a further complication and absurdity, obviously, which is that many of the products that remain on the restricted lists are products that are easily and quickly available in other countries. They are being back-channeled to other nations, and we are like an ostrich with our head in the sand if we believe that somehow we are protecting ourselves while other people go out and grab these markets.

Then to make matters worse, as many of you know, because we have been shut out with an original part or an original particular product line, many of the RFP's that go out from other countries then exclude us from participation because they do not have confidence in our ability to provide the parts, or because they do not want to put up with the absurdity of our licensing process in this supply chain.

To put people through a 2-year rigmarole from the Government to be able to get into a market is to say we are not really competitive and we do not really want to be aggressive about things.

So I personally am very, very upset about it. I want to hear from all of you about the many different things that we ought to think about doing to try to deal with it.

There is new legislation that I have here which we can think about later talking about. Let me just read you a quick editorial to share with you and help frame the discussion a little bit. This is last Thursday, just to show you how relevant the discussion is, in The Washington Post. It said the following:

> Computers are going to be essential to the job of drawing Eastern Europe into the worldwide networks of commerce and communications. The Eastern Europeans are going to need them for, among other things, air transport, telephones, and banks that meet Western standards. But selling big American computers and other high-tech products to these recently communist countries is restricted and often prohibited by the law that controls exports of high technology. That law expires in September. It needs to be extended, but it also needs to be drastically narrowed and reformed.
>
> The Export Control law covers sales of advanced equipment to the United States Allies as well as to its adversaries. An American exporter needs to get a license, not always a quick or simple process, to ship certain kinds of equipment to a customer in say France. That's turning into a serious competitive handicap. American exporters report that Western European customers are beginning to avoid buying advanced technology from the United States because they don't want to risk being caught in the internal quarrels that frequently complicate and prolong the licensing process here in Washington.

Now we have a $150 billion trade deficit—$50 billion with Japan—and obviously the time has come to redefine "national security." It seems to me that the national security of this country is not served well by cutting ourselves out of the marketplace. So it is going to take, needless to say, a certain amount of push from you, all of you, as opinion leaders and also from us in order to rectify this current process.

Two years ago, as part of the Omnibus Trade Act, Senator Cranston and I rewrote aspects of the Export Licensing laws. They still have not fully implemented the regulations, and we still are going through this tension between the Defense Department, the Commerce Department, and it seems like we have this sort of suicide will to deprive ourselves of the fruits of our ingenuity and of our labor.

So without further ado, what I would like to do is begin this focus—let me say one other thing. Obviously there are some macro economic decisions that have to be made which affect all of this: the deficit, our current interest rates; there are some major choices we have got to address—the current credit crunch here in Massachusetts and elsewhere in New England and in the country. These are all problems, and I do not mind anybody citing them or spending a moment on them, but the focus of our energies really ought to be on two critical components, and you suggest to me if there is a third or fourth. I may have narrowed this too much.

No. 1: Export licensing. What do we do to accentuate the export capacity of the State of Massachusetts? And what can Federal policy do to make things happen?

No. 2: Research and development. What can we do to excite the R&D and the incentive process for the creation of those products that

will then hopefully get through an easier licensing process and get into the market?

Now one thing that we ought to do that I am proposing in my legislation is, obviously, take the restrictions off of trade within the countries of CoCom. There is no reason in the world for us to be requiring 35,000 licenses annually for exporters to get into the marketplace with those competitors who have no such requirement when trading with us. I think that is fairly obvious. There are some other things in terms of the definition now of what products go to Eastern Europe versus the PRC, and there may be some other clear-cut issues that you would like to raise for the first time here.

So I would like to just throw it open. Again, we really want to have a lively, open discussion. Each of you brings a particular expertise to the table—or several, for that matter. What I thought we would do, just to start off with, is run around the table and have each person very quickly just identify themselves and what brings them to this table by virtue of background and interests, and then we will begin.

So why don't I start right here with our host.

## EUGENE WEISBERGER, PRESIDENT, DEFENSE SYSTEMS GROUP, GENERAL INSTRUMENTS

Mr. WEISBERGER. Thank you. I am Gene Weisberger. I am President of the Defense Systems Group of General Instrument, of which the Underseas System Division that you are in presently today is a part. We have been in the ocean mapping business for well over 30 years. We were the developer of this technology. We held the patent for many, many years. We supplied these systems on a technical level and a highly military level to the Department of Defense for many, many years.

Admittedly, during those initial years of the deep cold war it was very critical to keep this technology and keep us advanced versus our enemy at that point. Our position is that things have changed in the last 5 years. Where we have been at one time the leader in the technology, because of the licensing restrictions other companies in other countries have gotten into the technology and are now equal to us. And to the extent we cannot get licenses for our systems—and we have specific examples of that situation—to the extent that we cannot get these licenses, we lose sales.

When we lose sales, we cannot support the technology. Senator Kerry just said the second issue he wanted to talk about was R&D. That is critical for us. These are high-technology systems. If we can't support the R&D and we can't get the DOD to pay for that support anymore, we just will not be able to keep up with the competition.

There are not many of these systems sold every year. They sell for about $2 million apiece. If we cannot sell enough of them, we cannot support and move forward with the technology. The competitors, on the other hand, selling those systems throughout the world and selling more of them helps to improve their technology to where they will be ahead of us very soon.

This is a microcosm of our total country's situation, and I am very, very much concerned about it. We cannot have a level play-

ing field—we cannot have an unlevel playing field and still survive. The great frustration we have with the Washington scene, Senator, is that it takes an extremely long period of time to get answers and to get action. I think it is critical for you—and you are aware of this, and I appreciate the efforts you are doing in improving the export licensing situation—but we have got to light a fire, all of us, under the seats of the people who represent us in Washington. They can no longer take 2 or 3 years to move.

The world is changing. We are not in the cold war anymore. We are in an economic war. Economic wars, I am finding, are a lot more difficult to win. We have the Japanese very aggressively going after our commercial businesses. How many televisions and VCR's do you see being sold, very few, made in this country? I am concerned about what is going to happen with EEC 1992. We see teams forming in Europe, the Siemens of the world, and the GEC's and the Thompsons that are going to clean our clocks if we do not do something aggressively about getting that informational business.

We as a country cannot survive on our own market alone. We must have the world market to go after. And to the extent that we are limited by this licensing situation, we are just going to lose out.

I think one of the things that is very critical is we have got to eliminate the thousands—you mentioned 30,000 licenses. I think that that is conservative. We have——

Senator KERRY. It is 35,000 just for the Coordinating Committee countries. For those countries. But obviously outside of it there is more than that.

Mr. WEISBERGER. We have to get a license, as many of you know, for every spare part after we deliver a system. For every piece of test equipment, after we get the system installed. Do you know what our competition, the German company, is saying to the marketplace? Don't buy an American system because you'll never be able to get it supported. If you've got a ship out there and that ship is down because it needs a window or a dome for this system, you can wait 6 months before you get the license. So General Instrument can't support your system.

That is very powerful ammunition against us. The Koreans, and the Japanese, and the Indians of the world, they don't want to buy a system that can't be supported. These ships cost $10,000 a day to support. How can you afford having a ship sit around for 6 months waiting for a spare part. That is our competition's argument. It is absolutely critical that we get around that.

So one issue specifically has to be resolved, and immediately: once you get a system license, you should then have a license for everything that goes with that system. That is one issue I would love to have addressed.

Senator KERRY. We will come back to that, and a couple of others you raised in the context of that. What I want to do is, before——

Mr. WEISBERGER. OK. Go ahead. Sorry.

Senator KERRY [continuing]. Is have everybody—no, no. You're our host, so you get to break the rules.

Mr. WEISBERGER. I get emotionally tied to these issues.

Senator KERRY. I want you to. But just a quick identification of everybody, and then we will come right back to the issues you have opened up.

**DONALD J. WHITE, VICE PRESIDENT AND GENERAL MANAGER, UNDERSEA SYSTEMS DIVISION, GENERAL INSTRUMENTS CORP.**

Mr. WHITE. My name is Don White. I am Vice President and General Manager of the Undersea Systems Division, General Instruments Corporation. I have sort of been with this problem for many years. I've got 27 years in this technology, so I kind of know what is going on.

**DEAN DAVID BLACKMAN, NORTHEASTERN UNIVERSITY**

Dean BLACKMAN. My name is David Blackman. I am the Assistant Dean of the College of Engineering at Northeastern University. My interest here is the manpower in the year 2000, basically those under-represented groups such as women, Blacks, Hispanics, American Indians, getting them into the field of science and engineering so we can still remain competitive.

**MS. CARLTON FIORINA, DIRECTOR OF INTERNATIONAL BUSINESS DEVELOPMENT, AT&T**

Ms. FIORINA. I am Carlton Fiorina. I am International Strategy and Business Development Vice President for AT&T Network Systems. Network Systems is one of the organizations within AT&T that manufactures and markets basic products to build the network industry like switching and transmission, et cetera. As such, international growth is absolutely vital to our survival because of the capital intensity of the technology we're dealing with, and export restrictions being lifted far above what the administration currently recommends will enable that success, because we are competitive at the high end of the technology.

**AL FERRARA, MRS, INC.**

Mr. FERRARA. My name is Al Ferrara. I work in manufacturing for MRS technology. I am on the opposite end of Ms. Fiorina. I am here to get the feelings—what it feels like to be in the manufacturing end and to see the foreign countries taking over. We have new developments and we are just watching them slipping away.

**GRIFFITH RESOR III, MRS, INC.**

Mr. RESOR. I am Griff Resor, MRS Technologies. My interest is similar to Al's on the AEA definition of systems task force and science board task force. We make equipment at MRS that is going to make a new type of color display.

Senator KERRY. Let me ask everybody to speak up just a little bit so that all the folks in here can hear.

Mr. RESOR. At MRS we make the manufacturing equipment for Enchalsford. The equipment will make possible a new type of very high resolution colored platen display. Most of the companies pursuing this technology are Japanese.

## MITCHELL KERTZMAN, CHAIRMAN, AMERICAN ELECTRONICS ASSOCIATION

Mr. KERTZMAN. I am Mitchell Kertzman. I am the current CEO of Computer Solutions in Burlington. We are a supplier of large-scale manufacturing control systems. I am also the 1990 Chairman of the American Electronics Association and we cover a wide spectrum of issues discussed here today from trade policy to science and technology, policy formation, et cetera. I am glad to be here.

Senator, you are to be congratulated for bringing Mr. Hertsberger out of his shell so often in the hearings. [Laughter.]

Senator KERRY. As you saw, it took a lot of effort. [Laughter.]

## JAMES VINCENT, CHAIRMAN AND CEO, BIOGEN

Mr. VINCENT. I am Jim Vincent, Chairman and Chief Executive Officer of Biogen, one of the oldest biotechnology companies formed here in Boston and Cambridge back in 1978, and one of the leading biopharmaceutical companies in the U.S. and in the world today. I am most interested in and certainly directly affected by the second item of your agenda, Senator, both in biotechnology as well as in previous years spent in the pharmaceutical industry. We are in the enviable position of both pharmaceuticals and biotechnology specifically of leading the world for decades in pharmaceuticals in unquestioned leadership in the world.

It has been largely based on research and development and success in research and development over many decades, and how we have continued to extend that success record in an overall picture of significant need for cost containment and health care in general is a very, very significant issue. So we are being careful not to throw the baby out with the bath water.

In your first agenda I also happen to have interest, although I don't have very much direct impact on it at this point, having spent the first half of my career in life with Texas Instruments in semiconductors, building their businesses in both Germany, and having to look Siemens, and Phillips, and the likes of those people in the eyes and build the business from scratch, and then managing all their businesses in the Far East and building them from Japan to Singapore, and having to look the likes of Hitachi and Toshiba and NEC in the eyes to compete with the head-on-head in their homeland to make integrated circuits.

So I will take great interest in struggling with the export control laws or anything else it takes.

Senator KERRY. Mitch.

## MITCHELL KAPOR, ON TECHNOLOGY

Mr. KAPOR. I am Mitch Kapor. I am President of ON Technology, somewhat better known as founder of Lotus Development Corporation [inaudible].

My principal interests are in understanding the Government's role in helping to promote innovation. Obviously a very important part of that is the specifics, both the why's and the how's of basic R&D funding. I also have a major interest in the area of intellectual property laws because I would say that one of the principal risks to our ability to continue to innovate is the development of an in-

tellectual property regime which discourages rather than promotes innovation. I have a couple of things to say about that later.

### RON BOHLIN, McKINSEY & CO.

Mr. BOHLIN. My name is Ron Bohlin. I am a partner in the Boston Office of McKinsey & Company, and I am the leader of McKinsey's practice area serving computer and office automation parts. So my clients are computer companies, software companies, and various other high-tech companies, by and large.

McKinsey is a broadly international firm and somewhat more than 50 percent of our business is outside of the United States. So as a firm we serve a range of companies on both sides of this question, and our role is to help them try to anticipate where things are moving, how things are changing, and how that might affect their strategies, their organizations, the way they operate. So we at least have a very robust discussion internally on the different perspectives someone might make on these questions.

### JACKIE BONNEAU, PHYSICS TEACHER, SHREWSBURY HIGH SCHOOL

Ms. BONNEAU. I am Jackie Bonneau and I am a high school teacher at Shrewsbury High School and obviously very interested in the research and development end of things and how to get students initially involved in science and math, and what industry and the Federal Government can do to help us enlist both minorities and all students. The biggest minority that I seem to have impact on are females, but we do definitely need to have more of them interested in science and math so that all of this research and development that all of you need will come.

### ROBERT TIRMAN, DIGITAL ELECTRONICS CORP.

Mr. TIRMAN. I am Bob Tirman from Digital Electronics Corporation. Senator Kerry has identified two areas of very important concern to us in export licensing and research and development activities. Having suffered the slings and arrows of outrageous misfortunes in both of these areas for years and years, we are particularly interested in some initiatives that have come from Senator Kerry's office, as well.

We are particularly interested in revamping the export licensing agreements and particular issues that may come out later with respect to advanced technologies, and likewise in the R&D area we would like to expand on that later on with our various concerns, not just as it relates to development but also in other competitiveness areas.

Senator KERRY. We would like to. Good.

### RUSSELL NEWMAN, DIRECTOR OF THE COMMUNICATIONS LABORATORY, MIT

Mr. NEWMAN. I am Russ Newman. I teach Communications Policy and direct the Communications Research Group at the MIT Media Lab. After you folks have settled the CoCom issue and we turn to R&D, I think we need about six focal points that will be the focus of energy and attention and convergence of energies, and I've

got one of them. So when it comes to my turn, I would like to identify that.

**MS. GAIL SULLIVAN, ESQ., BOSTON DIGITAL CO.**

Ms. SULLIVAN. Hi. I'm Gail Sullivan. I'm from Boston Digital Corporation in Milford, Mass. We produce world-class machine tools of award-winning designs. We are a Massachusetts success story, and we are very interested in this discussion. We have had problems of the type Mr. Weisberger has discussed in exporting, and it has been exceedingly difficult to get the licenses and deal with the Government bureaucracy. We have asked Senator Kerry in the past for help, and we have received help from his office for which we are grateful. We do feel there are reforms and changes needed in the laws so that we can continue to be a success in this State.

Senator KERRY. Well, I think everybody can see from the shared experiences around here and backgrounds that this is really an extraordinary gathering. I hope we can use that expertise and be fairly succinct and to the point, but I don't want to hold back anybody's emotion here. I really don't. I want to hear the anger, and I think it is important that we all express it.

I am as frustrated as the next person. It drives me nuts to see the kinds of things going on where we are in this very sophisticated international fencing game and we are sitting in this match, having nailed one of our feet to the floor basically, and we continually do it which is just absurd.

Let me give you sort of a late example. This is from National Journal about a week ago:

> Bulgaria has offered to sell one of its home-made super computers to the Energy Department's Los Alamos National Lab, a research center specializing in nuclear weaponry. Bulgaria has already sold one of the machines, which runs at only 1/20th the speed of the fastest United States made super computers, to the Soviet Union. Los Alamos is studying the Bulgarians' offer.
>
> Under current United States export controls, an American firm couldn't sell a similar computer in Bulgaria. That might compromise national security.

Now in this name of this process, in 1985—these are the only figures we could get—the National Academy of Sciences says that in Massachusetts we lost because of the export licensing system 6,000 to 24,000 jobs. We lost anywhere from 12,000 to 70,000 jobs as a result of the spinoff loss to the economy of those original jobs. So clearly this restraint is holding us back.

Now let's get into that a little bit, beginning with the issue of the export licensing controls.

Mr. RESOR. John, I think you have touched on the key issue. That is the question of foreign availability. For those of us who have been involved in export controls, the argument boils down to that, to worrying about market share. Market share is a threat when there is foreign availability.

One thought would be to set up a technical board independent of DOD and Commerce who might be the final arbiter. Commerce and DOD are the final arbiter on foreign availability. They can only win by being conservative. They made a mistake and allowed the export of a Toshiba machine tool for submarines, propellers or something, that had to go through the approval.

I know, having been in that game for many years, and those of you who are still in it can comment, but you touched on something that reminded me of an acute issue in that area. Maybe in the new bill you could set up an independent decisionmaking body that would be more objective.

Senator KERRY. Let me ask you this: Should the Defense Department be the final arbiter? Or should Commerce, or should State have the final arbitration over the defense issue? And what happens when it is dual purpose, dual use? How do you define it?

Mr. RESOR. I would rather you ask somebody who is currently in it. I have been out of it for awhile.

Senator KERRY. Gene.

Mr. WEISBERGER. We have had that situation many, many times. The DOD position has never been one of real concern about our trade policy. They have one issue, and that is simply to protect the level of technology and the advancement that our military has vis-a-vis the world. They are not looking at it objectively at all. They should not be the final arbiter.

I do not know whether another agency or another committee—you see, you get sort of paranoid when they add more bureaucracy to the whole thing. We tend to feel that probably Commerce would make sense to be the final arbiter, because they——

Senator KERRY. Well, you see the counter-argument to that, obviously, is Commerce is single-minded on the reverse. So the question is—which is why the independent concept comes off—do you need someone who is independent?

But let me ask, do we need to think differently about the national security issue now? That is really another issue. Yes, Mitch.

Mr. KERTZMAN. Well I think part of the problem we have here is this defense focus versus commercial focus is pervading all our special policy programs in defense procurement, export controls, and we have a single-minded slant of the world, which is that we view for instance single-mindedly through State and Defense eyes as a friend, despite all the evidence that they are targeting with hostile intent many of our domestic industries. We view the East Bloc and the Soviet Union absolutely as enemies, despite the fact that they have significant needs and designs in the commercial area and cannot even apply these resources without a going through this infrastructure.

That problem pervades every part of the Government. So I think unless you start changing this mindset toward a more complex world where your competitors are also your partners and your customers, which is happening in our industry and it is happening in the world politically, then you cannot choose one agency or another because you are not going to get around this pervasive dogmatic mindset view of the world.

Ms. FIORINA. Let me echo that, particularly in the field of telecommunications. We believe that civilian telecommunications do not contribute to military potential, and in fact an argument could be made in Eastern Europe that a robust network infrastructure is vital to continued democratization of those societies because it contributes to the free exchange of information and ideas, and it is also vital to the continued economic progress of those countries. Because without an effective telecommunications network, these

countries will not be able to attract more business, and more business is vital to their economic success.

So you can in fact make an argument that without civilian telecommunications, the military potential is increased rather than decreased. In fact, the current telecom restrictions, as well as the administration's most recent recommendation, although that is a welcome first step, those recommendations do not address areas that are vital to building an effective civilian telecommunications infrastructure.

They do not address signaling, they don't address network management. Those happen to be areas where American industry is most competitive, because we have designed equipment for the American network which is the most advanced in the world.

Under the current set of export restrictions, as well as the administration's recommendations, we are at a severe competitive disadvantage in those areas, and indeed our customers, or our potential customers in Eastern Europe, cannot build the kind of network infrastructure that they want and need, and they are being asked to spend additional money on technology which must be retrofitted to meet the current and recommended level of export restrictions. So for them it is a dump of money, as it is for us.

Senator KERRY. Let me ask a couple of big questions. Is it not true that if we do not sell almost any item to one of these countries, they will either develop it themselves or buy it from someone else? Is that truth?

Ms. FIORINA. Absolutely.

Mr. WIESBERGER. That seems to have come clearly to us. We have sort of an arrogant attitude in this country, and I think our culture has to change. There are technologists in Israel, a third-level country, that are at least as good as us in the defense area. The Japanese certainly are as good as us in so many different areas. A change in culture is necessary in our country that we are not the world's greatest everything, and that the sun does not rise and set around us as we tend to believe it does.

Now we have great examples of when we try to sell a system competing against the French, for example, or against the British, we try to sell a system in Malaysia and Singapore, Margaret Thatcher went into Singapore to push for the British system. When a competitor from France tries to sell a system, the ambassador from France will go in with a team from Thompson CSF. There is a relationship, and it is a cultural thing, that has taken place with these countries and these foreign competitors that they go in as a team.

They represent—you can say this is a restraint of trade, and there is monopolistic stuff, but we are competing against people that are very tightly coupled with their governments. We don't have that. When we go in, it is typically that the Government says "we can't get involved with that; that would be unfair." We have to become a little bit more unfair. We have to become unfair in the idea that we have to win.

I think your telecommunications system is a great example.

Senator KERRY. Well is it really a question of being unfair, or is it a question of doing unto others as they are doing unto us, at least until we get everybody to agree not to do it to anybody?

Mr. WIESBERGER. I think everybody is going to do it to everybody else because it is going to be a tough economic world, and only the strong—when I said "unfair," I was being facetious in a way. We have got to be tough. We have got to win the programs.

The Japanese are so great at selling—at wiping out competition. We have no idea in this country really how to win and wipe out a market. Except we should have this idea because we wiped out our semiconductor market. What has happened in our semiconductor business? We are literally out of it.

For all intents and purposes, that little Island nation has wiped us out. And whose technology is it? Its ours.

Ms. FIORINA. That's right.

Mr. WIESBERGER. And if we do not realize that, we are going to lose the other gains, as well.

Mr. VINCENT. Senator.

Senator KERRY. Jim.

Mr. VINCENT. One of the things I think when you ask a question in a binary sense, where to make it real is to have a time grid. One of the distinguishing characteristics of all of your high-tech, or most of your high-tech business is they are moving very rapidly. So that if you were to just take one cross-section snapshot of a subject that says what should be permitted and what should not be permitted, incorporating all interests at zero time, and you look at that 1 year later, the change is so rapid, the patents published, what was sensitive today becomes in many of these industries becomes obsolete in as little as 12 months, or even 18 months. That is a long time.

Senator KERRY. We can actually have a company still wrestling for a license for something that has become obsolete in the meantime.

Mr. VINCENT. The point that I am trying to make is that the difficulty in designing I think any system here that is administered by the Federal Government, or a Government agency, is how do you both make your decisions at zero time, but how do you build into the system to make it dynamic enough to deal with this rapidly changing situation? That to me is the complexity, the tie factor.

Senator KERRY. Now are there still items that would clearly fit under the national security blanket? Are there things that you clearly do not want to allow companies to sell, still?

[Inaudible simultaneous comments.]

Senator KERRY. So if you accept that, but you accept the other side of the coin—which is that they will develop them or buy them from someone else—how do you resolve those two tensions here?

Ms. SULLIVAN. I think in the area of telecommunications, one of the recommendations we would make is that we establish a policy of national discretion, and a nation's job would be to confirm in essence that telecommunications would be used for civilian purposes.

There is no question that there are real national security issues and that certain technologies should be prevented from being exported for military use, but in the area of telecommunications there are ways of verifying and ensuring that telecommunications technology is being used for civilian use in a nation.

There are varying degrees of technology. For example, technology that is used in manufacture perhaps should be regarded more

carefully than some products that are sold, but a policy of national discretion, getting out of this least-common-denominator approach of all CoCom nations, which is the current administration recommendation, is—and time is a critical factor. When it takes 18 months to get a license, if the technology is not obsolete, the market window is closed. And a policy of national discretion aimed primarily at verifying usage for civilian purposes I think would relieve the issue of time as well as to distinguish between technology that needs to be protected in a continuing basis and technologies which do not.

Senator KERRY. Mitch, you wanted to follow up?

Mr. KERTZMAN. I suggest in terms of this commercial mindset, in the commercial world it is not unusual—and in fact it is almost 100 percent true—that when you sell a customer a fairly sophisticated system that you also sell them installation, maintenance, support services as an ongoing relationship which is the equivalent of onsite inspection. In other words, it is possible to know what your customer is doing.

From my point of view, if a foreign country truly has commercial intent, they would have no problem entering into such a relationship with the suppliers. And the absence of willingness to do that to me would be one real test as to whether or not they really intend to put them to commercial use. So I think that in a commercial world it is far easier to verify the actual application of the technology than it is in the defense technology.

Senator KERRY. Now let me ask somebody, describe for me a real situation of the scare tactic that is entered into in terms of one of our companies getting into a market, because people over there are scared to deal with us. Has anybody got an example of that?

Mr. WIESBERGER. I think the CV was a great example. We sold the Germans two CV's before the Cryept Atlas Company got into the business. During those 3 or 4 years when they had our CV's, this is a system that has equipment strapped to the bottom of the ship. There are transducers on the bottom of this vessel. They get damaged. They have to be repaired. They need spares. This is a very high-tech product that requires the continual support.

Every time we had to get a license to do something for that ship, it took 3 or 4 months. Now can you imagine a ship coming into port and looking at the under-hull of the ship, an inspector looks at it and says, I need a new window; the window got cracked in the last visit, the last deployment. He calls up General Instrument and says, send me a new window for the bottom of the ship. And we say, wait a minute, we can't do that. We need a license.

These are examples of again and again what happens.

Senator KERRY. So already having sold them the very window, you have to go back and get a license to replace the window?

Mr. WIESBERGER. Yes, sir.

VOICE. And in the meantime, they are trying to schedule drydock time. Very often drydock time has to be scheduled 3 or 4 or 5 months ahead of time. And when you schedule drydock time, you better be there with that window for the number of days. In the meantime, we are sweating out getting a license so we can ship the material.

Mr. WIESBERGER. Well, that country was the primary mover of getting their own system because they recognized the importance of this undersea map.

Senator KERRY. Then once they got their own system, we turned around and were prepared to buy their system. Right?

Mr. WIESBERGER. Yes. Not only that, but we did.

Senator KERRY. How does that make you feel?

Mr. WIESBERGER. Not only that, when they sold it to the United States—because they recognized that they didn't have any, this Creypt Atlas Company, didn't have any experience in the technology, and the way they got the credibility is to sell one system in the United States. The system that they chose, they marked down by about 50 percent so that our Government—and this is what you call classic dumping—our Government bought a system at $1.3 million on a $2–2.5 million system, to an agency, and then this very aggressive German company went around throughout the world and said, see, our system is as good as the General Instrument System. We sold one in the United States.

I was confronted with that by Dr. Park in Soul, Korea. The Korean Oceanographic Institute is buying a system, and the Germans were there selling it and they said, see, we have a system as good as the U.S. system. The United States just bought one.

So they turned right around and used as their marketing approach, even though they didn't have a single system mapping anyplace, but they used as their marketing approach the fact that we just sold one into the United States. So the strategy was clear: Get into the business. Dump one into the United States. Show credibility. Now catch the business worldwide.

OK, we are fighting like crazy to get that Korean business, and all of a sudden we find out that there is an opportunity in India. India is a Third World country, and they would like to have two systems. You go down to the State Department and the Commerce Department, and DoD, and they say, India? We thought we had leprosy or something like that. No way could we get a license to sell to India at all.

So what did we succeed in doing? We got two systems sold, Creypt Atlas, into India at full price at $2.5 million apiece. Now they have a nice, great big backlog where they can pay for their technology to move their system forward. We could not touch them.

Spain? We did not even know about the Spanish opportunity because there is something that we have talked about at EC 1992. These countries are already getting together. ECC 1992 is really here. The French system. We lost that one. Don't buy an American system, we have problems with the license; buy a Norwegian system.

We went from being a high-tech, premiere company who did a good job with the U.S. Navy and with our customers to where, instead of being the top in the business, we are third. Here is a case where our CoCom partners——

Senator KERRY. Let me ask if I could—go ahead.

Mr. WIESBERGER. Excuse me. If you wonder what CoCom is all about, here is a case where our CoCom partners sold two systems to India and we were denied a license. It's terrible.

Senator KERRY. Al Ferrara, I want to ask you. You are a technician and you are on the front line here, and you have expressed this frustration. What is your view of this, and what do you think we ought to be doing about it?

Mr. FERRARA. Well, I am not an expert on world bids, but I can tell you that the general reaction in this business is most people—I'm not speaking for myself; I'm speaking for the people in manufacturing—is we feel like America is losing out to the foreign countries. Business and Government now are relying on equipment, on financing—say, for instance our MRS machine, the only interesting part is in that machine from the foreign countries, and we have worked hard to get that machine up and going only to see, like most products in the United States, it be swept by foreign competitors. That's about as much as you can say.

All we see is other foreign countries coming in, whereas the Americans, again as people are mentioning, the support and all that is a factor and we are just being swept.

Ms. SULLIVAN. I agree. There is that feeling, and it is not just a feeling, it is a reality. I think that when we speak of the support the Japanese can count on from their Government when they want to do trade and when the Germans want to sell something, you know that their government is supporting them.

We do not have that feeling in this country. We do feel that the DOD is a real problem. Our Government bureaucracy looks at us very suspiciously when we want to engage in business and trade, and it is exceedingly difficult. It is our most successful companies which are hurt the most.

I mean, our Government aides are failing businesses. The automobile industry gets help, but our success stories are hurt. The bureaucracy is incredible. We went through approximately 2 years trying to get an export license to India for our five-access machine. The technology, we had to file an appeal. We went through all kinds of mindless steps. We have a huge file on the case. And the technology was already in India—American technology. I don't know how the five-access machine got there, but we were selling a machine to an educational institution, and we said we have reason to believe that this technology, this very technology, is in India. Ours is somewhat better quality. However, it's there. They have this capacity.

And finally Commerce sent a man to India to view this, and he eye-witnessed the machine. When he eye-witnessed it, it did help our case somewhat. But it is amazing. Not only that, but were the American technology not there, the Swiss would have readily sold this equipment, we are quite sure. The Germans, the Japanese, whether they should have or not, they were ready to sell. It is hard to hold a customer under those circumstances.

As far as suppressing ideas, totalitarian countries have not been successful in doing it, and they have made great efforts. It is hard to do that. Ideas become obsolete in 6 months, 18 months. It is hard for Government agencies to keep up with this, even when they want to help you.

After our sale of a five-access machine, we had a three-access machine we were going to sell to India. This is not perceived by our Government as any problem, but nevertheless it requires a license,

et cetera; and just to get this moved along in a situation where you don't have a problem with the Government, where there isn't any obstruction whatsoever, it took at least 6 months.

When a machine sits on the floor of a plant like this, you lose money. And really our Government wasn't trying to hurt us in any malevolent way, yet the bureaucracy existed. It is cumbersome, and it is very hard. How many times do you want to call Senator Kerry's office and bother these people when you know that they are trying to address many, many issues of many companies in a State? And the Government really isn't trying to hold you up, but it did seem extremely mindless at that point.

And I know the Japanese are aided. Those industries are aided. We really do have to have a coalition of Government and business working together to make America a success. If we lose our industry, if we can't manufacture, we will lose our place in the world and we won't be able to produce anything. We won't be economically strong. We won't be able to provide a good life for our citizenry, and we want to do that.

So it is extremely difficult. We need help, and we need sensitivity on the part of our Government. I do think Commerce is more sensitive than DOD, certainly, and I know some effort was being made by Senator Kerry's office to perhaps have some local division of that Department here.

I think Massachusetts and New England is a location where we have so many high tech firms that are successful, but are particularly hampered by these considerations. And these are American success stories, and these are the industries which should be unhinged, really. We have shackles on our feet. Our Government shoots itself in the foot constantly with respect to these things, and it is mindless to go through this kind of time and bother when an industry like yours can be so successful if allowed to be.

VOICE. One of the things I think——

Senator KERRY. Let me just insert here, if I may quickly. First of all, we do not have any feet left.

Ms. SULLIVAN. Right. [Laughter.]

Senator KERRY. We have been shooting ourselves so far, we are aiming at major components of the body now. [Laughter.]

Ms. SULLIVAN. The heart.

Senator KERRY. Second, let me put CoCom into context for some of the members of the press who aren't—and even some folks here aren't familiar with it. CoCom stands for the Coordinating Committee of the multilateral export control structure. In the 1940's, and in 1940 as a matter of fact, with the outbreak of the War we passed the Export Control Act giving the power to the President to be able to not see certain technologies go to our enemies.

In the aftermath of the War, that was codified among other nations in order to guarantee some process by which we didn't see items of national security go to the Soviet Bloc and so forth, and also to permit us to restrict, in certain cases of furthering foreign policy, we would restrict certain trade as a result.

And finally, we were allowed to do it in situations where there was a scarcity of products in this country, or to prevent inflation or something. So we gave him sort of three tools which he was allowed to use.

The CoCom countries are all of the NATO countries except for Ireland, and then Japan and Australia. We are supposed to still work by the same Protocol. Just to give you an example of the difference, in the United States the average 1989 license approval time was 120 days. In Europe, it was 14 days. In Japan, it was 4 days.

So I think we have established the problem. We have talked about the sort of larger aspects of it. So that we can have time to move eventually on to the R&D part and some of the broader things that some of you may want to talk about what we need to drive the economy in Massachusetts, and I want to hear that, but let me come back on the export licensing piece.

What are the other specific concepts. We have an independent board concept, which may make sense, as a means of resolving this faster.

We ought to take the CoCom countries by and large off any licensing requirement. Is there any disagreement with that?

[No response.]

Senator KERRY. What else do you think we can or should do to streamline this process and to make it work better for us?

Mr. WIESBERGER. Reduce the number of components on the list.

Senator KERRY. Take more items off the list.

Mr. WIESBERGER. Absolutely.

Mr. RESOR. Review the list more frequently.

Mr. WIESBERGER. Start out now with a much, much smaller list. Right now it is so encompassing that they cannot move it in less than 120 days.

Ms. FIORINA. Another idea Gene brought up is some allowance for spares.

Mr. WIESBERGER. All support and spare equipment, once you have the license, should be automatically licensed.

Ms. SULLIVAN. License the system, as opposed to the parts.

Senator KERRY. Right.

Mr. WIESBERGER. Right.

Senator KERRY. That is in our current reform legislation.

Mr. WIESBERGER. And license the software with it, because the CoCom countries all license their software.

Mr. VINCENT. Senator Kerry, if you are ever going to be able to keep this, whatever one does, up to date in a timely way and still be effective where you want it to be effective, there must be some role for industry here. Industry is where the knowledge exists most currently as to what would be sensitive, both positive and negative.

Mr. BOHLIN. Senator, before you leave this topic, there is just one practical consideration that I would like to point out. That is, that however fast you think the political process is going to move in a place like Europe, I think the commercial process is going to move even faster. What we are going to be seeing is companies that are increasingly difficult to pin down just what their home country is, and where they operate.

So from a practical perspective, it is going to be increasingly difficult to administer this, particularly when what you are talking about are companies out there—like let's take an Erichson who might buy a minicomputer and embed that minicomputer in a

system that it would be aggressively selling throughout all of Eastern Europe and anyplace else.

How you apply these kinds of regulations under that kind of situation, and worse when you no longer can say to yourself that Erichson is no longer a Swedish company, it is Erichson and Hughes, is all of a sudden a company that has no home base and is something that you have to anticipate in this. We see that as being much more likely to hit sooner than——

Senator KERRY. How do you anticipate that? What do you do to deal with that?

Mr. BOHLIN. You have to decide whether it is base technology that you are regulating, or whether it is the application of that technology that you are regulating, and what the role of the potential partner companies are in administering those regulations.

Senator KERRY. Well now you have raised a very interesting point underneath your question, which is: Because corporations are clearly moving—not even moving in; they are in it. The world is obviously this global marketplace. We all talk about it and pay a lot of lip service to it, but we have not really acknowledged in public policy the implications of that world marketplace on the more traditional decisions we make as governments.

It seems to me that countries which are more significantly dependent on trade, are countries that are far less likely to have the old kind of lines drawn between them and traditional sort of defense issues to fight about. This is why I am convinced that in the future there is going to be a new context of economic and environmental choices rather than these old, traditional arms control block country choices.

Now if that is true, are there not far fewer items that fall into that national security concept? And picking up on what Carlton said, do you not want to encourage Eastern Europe to, as rapidly as possible, become a freer, more open society that knows how to use those technologies so that they are in fact less likely to ever go back to where they were even to be able to go back?

Is that not part of this policy? We have not really touched on that. Am I wrong on that? I see heads nodding, but the record has a hard time recording nodding heads. [Laughter.]

VOICE. You are absolutely right, Senator. [Laughter.]

Senator KERRY. All right. Amen.

Ms. FIORINA. Senator, let me just touch on one of the things. I think you made a comment earlier about isn't it time for the U.S. Government to be unfair? I would characterize it a little bit differently. I think the administration talks frequently now about our role to be winners and losers.

I think what the Government is having a hard time dealing with is the fact that, particularly in high technology—and we have said this a number of ways around the table—international markets are now a matter of survival. They are not a matter of discretion. And they are a matter of survival because we need that kind of volume in all of the industries that are represented here. It is a matter of our survival.

Now it is not appropriate for the U.S. Government to pick among American companies and decide who should be the winners. I would argue it is absolutely inappropriate for the American Gov-

ernment to participate in ensuring that American industry wins vis-a-vis other nations.

In order to do that, I think they have to take a more active role really in four areas. Certainly CoCom restrictions and the whole area of export control is one.

I think we have heard eloquent statements on another, which is Government advocacy. We simply can no longer have a Government that says, hands off, I am not going to get involved, particularly because most of the purchases that we are talking about here today are purchased by governments. So the Government to Government interaction is a very important piece of the purchase position. That is certainly true in our industry, and I believe it is true in General Instruments and its industry, and it is true elsewhere.

The third area is market access. We have the people who could work aggressively to ensure market access. We support resolution as opposed to allegations, and we are encouraged by some of the recent decisions on Korea, but the facts more to market access that continues to be a problem. And this is the most open market in the world.

And the last area, which I think frankly is equally vital and particularly in places like Eastern Europe, is the area of competitive markets. We will be getting into that when you discuss the R&D, but when we go into countries, particularly those without foreign currency, and we are faced with competitors who have an active government advocate and they have financing packages which we cannot match, and they have export restrictions which are not even close to our own, that's it.

So it is really a package of four things that I think the government has to look at very differently than they have in the past.

Senator KERRY. I think that is a very articulate and good statement about where we have to go, and it is also a very nice segway into the R&D piece, which we ought to begin to start to talk about a little bit here.

As I said earlier, I do not want to just focus on the R&D. There are other aspects of things that affect a company's ability to set funds aside for R&D and to be in a position for it. So we are really open to all of that.

But let me perhaps ask the first question about it. What is there, if anything, about the export licensing process that has an impact on R&D? Is there?

Mr. KERTZMAN. I think it is the issue you just heard, the economies of scale on the global markets in order to fund the kind of R&D you need.

Senator KERRY. So it is basically a question of availability of markets. To the degree that you lose the penetration of the markets, you are losing your economy of scale.

Mr. KERTZMAN. And manufacturing technology, right.

Senator KERRY. Now for Massachusetts, we are particularly sensitive to this, obviously. What are the key ingredients that the Federal Government ought to be focusing on now that will strengthen our position with respect to the development of new projects and penetration of markets?

Who wants to start? Yes.

Ms. BONNEAU. I do not think your R&D is going to survive unless we have a lot of support for general public education, unless you have some people excited about technology. You are not going to have the creative ideas coming through. The students are not going to be going into areas like science and math and technology or engineering or computer science.

The Federal Government could take a big step, and so can all of industry, to really support that public education market and make a sizeable difference in the quality of the students coming out that hopefully will give you your new ideas for technology that will allow us to remain in the running.

Senator KERRY. I happen to agree with that very strongly. Is there anybody here who disagrees? It seems to me one of the problems is that public education in the past has been too segregated. People sort of shove it off over there. Well, here is the education system and we hope our kids get a degree and they can go on to higher education.

But it has not really been something that people say, hey, wait a minute, this is part of business. This is essential to business. There is in fact a critical component of all the businesses in Massachusetts in a sense, and in the country, being more invested in the education system because they are so closely tied. I do not think that has existed. I agree with you. I think it has been on a separate track.

Ms. SULLIVAN. We have been very fortunate. Digital has come in, in fact to offer kids a partnership and has been very, very active, but this is a very limited situation. GTE has——

Senator KERRY. But do you not think we ought to have that more institutionalized, and more encouraged?

Ms. SULLIVAN. Yes.

Senator KERRY. Now how do you do that? Is it by a tax credit structure to the companies? Or should companies do it anyway?

Ms. SULLIVAN. Well, I do not think companies are going to do it anyway. In fact, companies do not have the money to do it anyway, but I think it is something that they can benefit from.

Senator KERRY. So should we be thinking in terms of a public incentive structurally?

Ms. SULLIVAN. I think it would be very helpful—very, very helpful. I don't know what federally exists right now as far as a tax credit proposal for that type of thing. I know GTE has a very large program for teachers, innovative teachers throughout the country, and Massachusetts is one of those States. Unfortunately, very few teachers do apply for those grants. They give teacher training. It has to be an established teacher.

I think that the other thing that—I notice you have a bill in front of you. The Senate says you are going to give credit to people who are in education and just coming up. You also need to rejuvenate the teachers that are out there, because in Massachusetts a lot of the teachers are being laid off. That is the new teachers who are being laid off. So what you are being left with are teachers who have been in the field for a long time, and industry could do an awful lot to help those teachers, those teachers who have been out there, the teachers who are going to be working with our kids for

the next 20 years. There are not that many people coming into education, because the jobs are not there.

When you lay off 300 teachers in the City of Boston, there are not a whole lot of new teachers out there. So that this bill goes a long way if we need new teachers, but I do not see that you need a lot of new teachers. There are a lot out there already.

Senator KERRY. Well, the layoffs of teachers right now is positively the wrong thing to be doing. I mean, this is not the moment to be laying them off. If anything, it is the moment to be hiring teachers. But that is a different issue.

VOICE. And perhaps if we do better in the trade war, we will have the money for this sort of thing. I do not think that the people of Massachusetts are not generous or not interested in education. I think we are an education State, certainly, and I think that if we can compete and do well in business, which is what everyone wants to do, I think that we will not have to lay people off and lay teachers off.

Senator KERRY. OK. Component number one, greater linkage with education and focus on education.

What else do we need? To what degree is either cost of capital itself or the current disincentive, the current sort of debt assumption incentive we have in the tax structure, or any other component of the tax structure, critical here? Does anybody want to tackle that?

Mitch.

Mr. KERTZMAN. Well, I would like to say first of all on the education issue that I do not think it takes Government incentives to do that. I think the news there is good. In AEA for example we are very penetrated now in the Lowell School System and it has brought to the system a business roundtable on a national basis with the IBM Corporation. More and more companies are recognizing the cost of the K through 12 system, never mind the incentives that one needs to invest in it.

As far as cost of capital goes, the cost, and more importantly the patience of capital is a whole issue on our agenda this year. Cost is really less relevant. I do not know very many companies that necessarily do not do things purely on the basis of cost of capital; but the patience of capital in terms of decisions is critical.

My company, thank God, is a private company because we have been investing virtually every penny we have in a long-term R&D project that I could not do if I were a publicly held company.

In this case I believe that there is an area here for public leadership, but the most important thing that affects this is the Federal budget deficit. More and more, I think that we have a schizophrenic approach to this in business, which is that we come to you folks and we say: You know, you guys should eliminate the federal budget deficit; by the way, would you please make the R&D tax credit permanent; would you please provide a tax preference on capital gains which, although I support it, some schools of Congress view it as revenue negative.

I think we need to send a stronger message. The ABA is about to come up with a—we support the Rostenkowski concept, and I think we are about to come up with a policy that basically says we will come and, just as the President is talking about, we will put every-

thing on the table, if we can get a commitment to elimination of the Federal budget deficit.

Almost everybody agrees that that is the number one factor driving the high cost of capital. I also think as a Nation we have to prove that we can make hard decisions and set priorities, and that is a good way to do it.

Mr. WIESBERGER. Could I object? I don't think the deficit is a problem at all. I think the deficit is a state of mind and, if we put that aside, it might not be as important as we really think it is.

What is important is the relatively short range of thinking in our basic financial markets. The CEO is given a bonus on the basis of his yearly performance that year. A 1 year time frame is no way to look at any long-range situation.

Look at the Japanese. They look at industries in terms of 10, 20, or 30 years. Their capital investment is over a long period of time. You have to think that way. You could have a zero deficit right now, but if a CEO—and my boss will hear me and he'll fire me tomorrow——

[Laughter.]

Mr. WIESBERGER [continuing]. But if a CEO can make $15 million in bonuses because the performance of that company's financial results that year give him his bonus, what is the incentive for him to think 5 years out? If he is 60, 62 years old, he is not going to be there 5 years from now.

We need really a reeducation in the financial area of this country to where we cannot only look at this year's performance. It is a cultural change. And, Senator, whether you had a budget or not——

Senator KERRY. Let me comment quickly, and then I want to get Dean Blackman to comment on the education piece before we move into a couple of the other areas in R&D.

I agree to every single thing you said today with the exception of the comment on the deficit, mostly because the deficit—the country is doing very well, except for our debt. If you could reduce the debt or take it away, we really would not have a problem. We would be able to be investing in all these things.

But because each year we are adding to that debt, we now have a gross interest payment of about $263 billion, almost the size of the defense budget. The fastest growing portion of the Federal budget is debt service. Because we have to borrow from other countries in order to support our debt, the interest rates stay high. The savings and load crisis is now forcing more borrowing, which is driving those interest rates up. So we are losing our options by virtue of debt.

So I am convinced that the single greatest thing we could do for Massachusetts is to lower the real interest rates. And you will not lower the real interest rates until you get the deficit under control. So that is my one disagreement with you.

But on the short term/long term investment, folks, Government cannot do that. I mean, it is the Securities and Exchange Commission Regs that drive this quarterly report syndrome that requires people to say are we going to meet the numbers, or are we not? But that is not a government-driven, per se, thing. If they were to change the reg, or business itself were to say to hell with these

quarterly reports, and investment analysts would begin to look at it differently, I think that could change.

Now coming back to the person-power issue, Dean Blackman, you are at a university that I think has the highest percentage of minorities in the State, and maybe one of the highest in the country. I understand most of the growth in our labor force is going to be in minorities and with women. Is that correct?

Mr. BLACKMAN. Yes.

Senator KERRY. So is there something we should be thinking about in terms of R&D and growth with respect to that reality?

Mr. BLACKMAN. Well, I think one thing is when you are looking at women and minorities, we are trying to focus on one thing. These groups need something important to do. These groups need something important to do—my voice is low.

What we are not doing, we are not planning for something important for these groups to do. We are looking at a public school system that has a method of tracking, and what happens is it is convenient for a minority to take let's say what I like to call "conversational math" to just get a great grade. All of a sudden you have good grades coming out of school, but you do not have substance. So that is what has happened to a lot of Blacks, Hispanics, and American Indians.

Women are treated somewhat differently. They come into the 7th grade, 8th grade, extremely well prepared. But what happens is somebody tells them, or somehow they track out of the science and engineering classes. I do not know why, but it just seems to happen. A lot of women go into education, biology, mathematics, but not into the hard sciences. Nobody tells them, hey, come into manufacturing; come into engineering; be a corporate president, or get something important to do.

Senator KERRY. Dean, can Washington do something? Should Washington even think about doing something about that? Or does that have to come out of the institution?

Dean Blackman. No, I think Washington has to think in terms of doing it, designing programs—the programs that are designed in some colleges to make the sciences exciting to get more people to go onto Ph.D.'s and to go into Masters and to do something on the science and math in the elementary and in the high schools; to do something about day care; to do something about the environment in the poor community.

Most of the people who are going to come into industry in the minorities are going to come out of the urban centers, and the urban centers are—we all know Boston is quite poor. So when a student has to go home and study in a room that he or she shares with two other people, it is not a place to study. So we have to somehow come up with some kind of a solution, some kind of a remedy to provide a student a place to study.

Maybe that is keeping him in the high school longer. Maybe that is keeping him or her in an elementary system a little bit longer to make sure that that studying is being done. That is an investment for industry, because if that doesn't happen we are going to be playing around with drugs in the next 10 years, we're going to be playing around with unemployment, lack of qualifications in the

next few years; we are going to have the same problems in the urban centers 10 years from now that we have now.

Senator KERRY. Can that be done solely through structural reform? Or does it need resource commitment, money?

Dean BLACKMAN. I think it needs money.

Senator KERRY. Now let me switch for a moment to the other side of R&D, or the couple or several other sides of R&D.

Mitch, you are a veteran of a start-up or two, now, and you have got some strong feelings I know about cost of capital and finding the money and so forth. What are your thoughts about the federal role here?

Mr. KAPOR. Well the first thing is I want to agree with what my namesake said, that it is really an issue not so much of the cost of capital but of the patience of capital. In an economy where there have been enormous incentives to turn a quick profit and to make a very short-term profit without adding any value to the economy, which is what the previous decade of LDO's have been all about, which, thank God, is ending, but who knows what is going to be the next one of these?

I mean, the issue—let me pose what I see as one of the key questions for Federal policy before answering it—is: What can you do to alter the incentives to encourage longer term investment?

Maybe it is time to consider changing the SEC regulations if that will really relieve some of the pressure on quarterly earnings. I want to say, I do not think in any sense it is entirely, or even mostly the responsibility of the Federal Government to set some specific policies here, but it may be useful to help point out some inconsistencies.

On the one hand you have companies saying that they have got this intense quarterly earnings pressure, which is why they cannot invest more in R&D because there is no payoff. On the other hand, it is those same companies' pension funds that are demanding that the companies that they have invested in show the profits. So I think it is there, on the other hand, for Government to ask for consistency in its partners in business.

The particular thing that I have observed—and this at best is a germ of an idea, but I want to offer it—is that I think that there is an increasing research gap. In the areas of high-tech that I am familiar with, there is, all in all, a substantial amount of funding which goes into very basic research in computing and supporting research in massively parallel computers, the next generation of super computers, and so on.

On the other hand, I see a lot of startups, and in the last couple of years I've seen the same problem come up over and over again, which is that investors are going to put up $1 million, $5 million, maybe $10 million and you have 18 months to 3 years to bring your product out on the market. Many of the problems that start-up companies want to tackle with that set of resources and constraints seem also to involve doing research—because the interesting opportunities are not so much the ones that are just around there for the pickings where all the basic research has already been done and now it is time to make a commercial product. There is still some working out of the problem that has to be done. But, if you will, it is not "basic research"; it is almost like clinical research. And here

is the germ of the idea—and you are going to correct me if I am way off base on this—but:

In the biological sciences, there are really two kinds of research. It is very basic research. How do molecules get put together? What is the basic working of the immune system? Things like that.

But there is also clinical research and clinical trials that are supported by NIH and other Government agencies. Like when someone thinks they might have a cure, or they have an experimental treatment, very often there are federally funded trials to see whether in fact once you take it out to people it actually works and what the results are, and so on. So there is clinical research that is a well-accepted category.

I am beginning to wonder if some of this research gap and some of the problems that the start-ups are having is not a function of an absence of attention and funding on what I want to call "clinical high-tech research"—not basic, but at the point at which you are trying to figure out how to commercialize something. Not a slam-dunk by any means. You may need to go through several years of work and of tests.

Let me have one more thought, please. Increasingly more and more of the high-tech opportunities are not just in one high-tech company selling something to another high-tech company; it is in high-tech companies selling things to the general public. We have these tens of millions of personal computer work stations, and all of a sudden there are major clinical issues of usability. Is this actually going to work for people?

So I am beginning to wonder whether there is type of, as he said, structural possibility—not just throwing more money at the problem, but rethinking what gets funded and how, and building on this notion of equivalent of clinical field test research in emerging high-tech areas.

Senator KERRY. That is a thoughtful set of observations. Let me ask you—and either you, Mitch, or some of the others—the availability of capital. I keep hearing from people that it is harder to find that risk money. The risk is too great, people do not want to put it up.

True? Not true?

Mr. KAPOR. I do not really think that that is true. I think you hear that because the frontier keeps moving on. The blue-chip venture capitalists still have hundreds of millions in their individual portfolios—billions altogether—and they complain there are not enough good opportunities.

What happens is, you get a first-wave of successful companies like in the work station market—you get Sun, and Apollo; and then you get the second- and third-wave and people are still, there are hundreds of people trying to start companies where the frontier has already moved on. So I think just in terms of gross dollars in the high-tech segments that I am familiar with, it is not so much a problem.

Yes, Griff.

Mr. RESOR. I have a problem with this discussion. That is, it assumes that the major economic commercial opportunities for the Nation can be funded by venture capital. Venture capital, there is no question, has made a major contribution, but the high cost of

capital is forcing venture capital into very quick-return projects. Mitch said 18 months to 3 years. The ideal venture capital investment was LOTUS. Two people, a PC, 6 months, and you have a $400 million product. [Laughter.]

Senator KERRY. I know you've read that in the newspaper. [Laughter.]

Mr. RESOR. The absolute product that venture capital will not touch is anything that requires $100 million and 7 years or 10 years, and that is what we need in consumer electronics. The problem in the electronics industry boils down to, in my view, that we have systematically as a Nation pulled out of too many end-use markets. We do not have to dominate them all; we do not have to be in them all; but the last one we are in is computers.

Senator KERRY. How do you do that, Griff?

Mr. RESOR. You have to have patient capital. It has become a buzz word. I remember General Motors in the 1950's, and I should not admit that, but they were patient. They had long-range plans. Partly they were rebuilding the world. With 2 and 3 percent money, I think you would suddenly find managers have a different view. It is simple math, if you look at discounted cash flow. A person who can borrow money at 2 or 3 percent can afford to take a long-term view. He can win in that ballpark.

A manager, like everybody in this room, who has to operate in the 10 to 15 percent return environment, has to win in 2 to 3 years and have the same performance as his counterpart in a low-interest economy.

Senator KERRY. Now the Japanese and the Germans have these unholy combines between the private sector, banking, and Government. That is how they have been able to subsidize effectively the long-term view. So the question comes back to us: In order to fight back, is that what we have to do? Or is there some other structure that responds to that.

Yes, Jim.

Mr. VINCENT. Like one of the other comments, I can't believe I am going to say what I am about to say, being the president of a Fortune 500 company and living that hell of corner-to-corner discipline that Wall Street plays on you, but I do have to support here some positive news that relates to the patience of the capital markets. Because I represent an industry and a company that, but for a great deal of patience, when you consider that to develop a drug today in this country you are talking 6 to 10 years and an amount of money between $100 and $200 million, roughly, here you have developed over the past 5 years for the first time in 30 years in this country six new drug companies on Business Week's 1000 List. Just 3 weeks ago, 1000 meaning the 1000 highest cap public companies in the country, six new companies that have been merged since 1965 in this industry, all but one of which is focused on pharmaceuticals.

So patient capital markets have been patient. It is not just venture capitalists. This has been done both first with venture capital and then public money after that. Most of the companies don't have a product, as I say, for 6 or 7 years from the time they start.

Now structurally my hot button would be when you just look at this industry, and before we get to a broader agenda, since it still is research driven enormously, is the leverage for the capital gains issue in this industry, and I believe R&D generally. This happens to be an unusually high-level segment for two reasons:

One, if you are going to wait that long for your returns, obviously the capital gains tax becomes a much higher leverage because of the time sensitivity. Number two, in order to regroup and maintain the world class people, and this industry is your hiring market as well as your selling market is where you have to get your talent, and in order to do that the equity mix of the compensation component has to be very significant—not just for a few——

Senator KERRY. Sure.

Mr. VINCENT. Every single employee in Biogen has equity.

Senator KERRY. And you can't afford to draw them in without it, can you.

Mr. VINCENT. That's right. So you better believe that when a whole company has equity, they are also very sensitive to the issue of capital gains, in the employment and maintenance sense, in addition to just capital markets and how they view their investment when they have to wait 6 to 10 years to see the results. And most of these companies have not made a profit cumulatively in ten years.

We just turned in the black for the first time last year, 12 years after the company was founded. That is fairly patient capital when you consider our total market capitalization is a half a billion dollars.

Senator KERRY. Now, Jim, your company is extraordinary in that respect measured against most other efforts in the country in the last years. I think one of the reasons is that the pot of gold that people have been able to perceive at the end has made up for some of the risk element. But other people do not always see that large a pot of gold.

Mr. VINCENT. I think, Senator, that certainly is a factor but even within that dynamic, going back to some earlier comments——

Senator KERRY. Yes.

Mr. VINCENT [continuing]. That people within this industry, where the pot of gold is there, you saw starting to occur in the last 18 months two tracks in the industry. There are 15 to 20 firms who have ready access continuing to the market and do to this day——

Senator KERRY. Yes.

Mr. VINCENT [continuing]. And another 75 to 100—there are 185 public companies in this industry—another 75 to 100 that did not have access to the market. So the markets are discriminating within the industry, even though the pot of gold is the same for all of us.

Senator KERRY. Now I have proposed—have you had a chance to see my capital gains reduction proposal which is a targeted capital gains tax reduction that has sort of two goals? One is to try to invigorate risk-taking on real start-ups. The second is to deal with this long-term view. What we do is, say for the first dollar up to $10 million in a new issue of stock, you would have a range with a 5-year holding period minimum 10-year period holding period, and you would range the tax from 5 and 10 percent per dollar to

$10 million, and for $10 million to $100 million you would have a 10 and 15 percent tax ranging for again 5 to 10 years' holding period, depending on how long you hold.

Does that address some of that need, do you think? Or not?

Mr. VINCENT. Well, something is better than nothing. You have to also realize that at a company like Biogen we have not 35 to 40 percent instutitional investments, various—necessaries, not just small investments. So to the degree that by putting timing constraints on, conceptually to some degree I can identify with timing contraints. You are not just looking for a short-term trade. But to the degree that by putting numbers, caps, and timing constraints on that you exclude the major capital suppliers out of the pension funds and large money fund managers, you will not address the issue. Because we will need capital for the next decade just as sure as we sit here in large quantities, a lot of which is going to have to come from the large institutional investors in large numbers.

Senator KERRY. Is that not happening now?

[The tape labeled "Tape 2" ends at this point.]

[The tape labeled "Tape 3" begins as follows:]

Senator KERRY. . . . 28 percent civilian. Is that having an impact? Yes, either Mitch, or Griff.

Mr. RESOR. One of the things that is of great concern to me is that we are losing our national agenda. The only agenda that we have had was opposing the Soviet Union around the globe. One of the great visions was the Marshall Plan, that economic support in time eventually would overcome communism; that we really did have a better idea. And that has turned out much better than any of us who grew up in that environment thought would happen—in fact, I had decided it never would happen in my lifetime.

We need a trade and commerce-oriented agenda at the national level, as Mitch has said. Our world has fundamentally changed I believe for the better. It is time we learned how to play that game. I strongly support the efforts to build the commerce focus within NSST—I hesitate to use the words a "civilian DARPA," but DARPA has definitely stimulated Massachusetts in the computer world.

Advanced computers that are critical to defense are the key to the defense multiplier that overcomes our lack of just shear numbers in the trenches, and it is time we formed this Government-industry partnership through NSST. I would turn gene's words around. I think other countries have a Government partnership with industry.

I have been asked for the last 2 years to bring to the Bush administration industry-led initiatives because government should not pick winners and losers. The message is loud and clear: The Bush administration does not want to listen to industry-led initiatives. What we are missing is a sense that the Government is essential—Government activities are essential to our Nation's competition in the commercial world.

AT&T said it very clearly earlier. So I would strongly go on record supporting funding for NSST and other committees, but it would have to go beyond that. Fundamentally we are missing it. We have to shift the national agenda. Once we have a mission like the moon shot as a trade mission, kids will see why it is important

to get on that band wagon and get educated and I think a lot of things will fall into place.

Until we have the agenda, it is just frustration pushing us.

Senator KERRY. Do I hear you saying in that—I want to be careful here because of the "winners" and "losers"; I think we get mucked up in that and it is a mistake—should we target industries? Or can you rely on the market to make that decision on its own? I mean, that is really the tension with the Government's involvement.

We have targeted industries in the past because we had another goal in mind. The other goal in mind was the national security, so we targeted McDonald-Douglass, Boeing, et cetera. We kid ourselves in saying we have not targeted industries, for Heaven's sakes. We certainly targeted Chrysler and the automobile industry with the bailout. I mean, we have done a lot of things over the years.

Should we now in the context of this description you have given about setting an agenda in business and so forth—and I agree with that, incidentally. I think that is the new agenda. Should we be doing more in the business and Government partnership for the R&D part? And does that not require a kind of targeting?

I mean, that opens the HDTV kind of issue. Should we not be putting more money into HDTV or other aspects of things? I see a lot of hands going crazy here. I promised to—let me go over here, and then I will come back down here. Sorry.

Yes.

Mr. NEWMAN. I would like to take as my cue this concept of a national agenda because, as I said before, I think I have a specific national agenda item. As a personal note, I would like to say I have heard a convergent song from those of you before, and it is a sad lament, and it is in fact depressing to hear the convergence of concerns.

What I would like to do is contrast that with a positive, forward-looking, and I think specific convergent set of issues that I think offer the opportunity and can bring a number of industries, including television and computers, together to move ahead, and in fact leapfrog initiatives that have taken place thus far in Japan and Europe.

Senator Kerry, what I would like to commend to you is to avoid the words "HDTV," because what HDTV sounds like is a very narrow targeting—that is, picking TV sets which are a free-standing item and turn to something more like ATV for Advanced Television, or DTV for Digital Television, or Advanced Visual Systems, and understand that what is at stake here is not some kind of a little box that sits like a radio or——

Senator KERRY. That is the old computer, obviously.

Mr. NEWMAN. It is part of an infrastructure, and the infrastructural issue is key. If I may, let me develop this notion of an opportunity with a national agenda item to move ahead of our competitors overseas.

When the Japanese first started working on "HDTV" in the early 1970's, they had a metaphor. The metaphor is: We have moved from radio to television, and we have moved from black and white television to color television, now we have got a new opportunity to move to slightly wider and slightly sharper television sets.

The other part of the metaphor is: This is the next VCR. It will be a Japanese dominated technology, perhaps, and it will generate a wonderful return for their R&D. They have been working diligently and fairly successfully, and they should be commended for that in developing their generation of HDTV.

But I think the metaphor is flawed. Because of the convergence of computers, television, and advanced display systems, we have got an opportunity now to understand that we are not talking about little free-standing devices that get only one way entertainment and slightly informational television in our living rooms and dens. We have a chance now for an expanded, controllable, two-way resource. This would involve I think taking seriously the expansion of a universal optical fiber system.

So if the Japanese proceed with a 1,000-line television, and the Europeans in knee-jerk response—and I think quite unthinkingly—respond with a 1,250-line television, again basically a 1970's analogue technology—and it is important to note that both the Japanese and the European counterproposals are primarily analogue transmission systems—and say, no, no. We are not copying. We are leapfrogging. We are moving ahead. We are going to understand that this is a multi-component system involved with optical fiber, and we have recognized that we have built railroads, we have built highways, we have built canal systems. The infrastructure of the information age is optical communications. Instead of pretending that that is somehow "picking a winner," it is generating a mission and a set of national goals.

I would venture to say, Senator Kerry, that it may not be necessary for federal dollars, per se, because the private sector will respond if the initiative is clear. Here your involvement in issues of communications' policy and oversight of the Federal Communications Commission comes into mind, and I think Al Sikes would respond very positively to a message from the Hill to the effect that we want to move ahead. We do not want to simply make the current process that the FCC has gotten itself all tied up in of picking one broadcast standard to determine the feature of the industry——

VOICE. Analogue broadcasters are in charge of that process.

Mr. NEWMAN. Absolutely correct. There have been responses just in the last two months. A committee for High Resolutions met, I met with them just last week in Washington to put a new concept on the table—and that is, digital television and two-way television—and to embrace this, and to set a goal, and a set of ideals. The hard work is going to be hammering out, because somebody is going to get an opportunity to lose what is currently their narrowly defined sector—the broadcasters, the cable casters, and the publishers who are going to be very concerned that the development of these new industries might develop new competition for what they have had as a dominated marketplace.

But that hammering out can go off within the industry once the message has been made very clear. I think the enemy is clear here. I think the Hill is hip. I think the enemy is the veto trio of Darmon, Boskin, and Sununu, and that we need to identify a vision that identifies itself not as ACTV, but as an advanced communica-

tions infrastructure and consider the Gore bill in this respect as just the first step.

I think, although there are going to be people who are going to be voicing concern that they might be dominated, these things can be worked out once the message is clear that we are going to go in that direction and it will be worked out.

Mr. RESOR. I absolutely agree with Russ. I have been proselytized by Bill Shriver of Media Lab. I see the Space Station and the mission to Mars as a subsidy for the air frame business and a major national distraction. This is the national agenda.

Senator KERRY. I'm sorry? Would you say that again, Griff?

Mr. RESOR. I said, the Space Station and the trip to Mars is a major national distraction. It will subsidize the air frame industry in Orange County, but it will not help the electronics industry.

Senator KERRY. Can we afford both?

VOICE. And still reduce the deficit, right? [Laughter.]

Mr. RESOR. What Russ has talked about will have a major impact on the electronics industry and the venture capital business.

Senator KERRY. And describe for me—I mean, assume—well, let me ask the question this way:

Is the mere definition of the agenda or articulation of the agenda enough to do that? Is that enough to stimulate that? Or do you need something more? Do you need the specific incentives and other things structurally built in so they are going to draw the capital in that direction?

Mr. TIERMAN. Senator, I think you need more than that. What we are talking about here is minimizing risk in four areas. One is market risk. I do not think anybody here is saying that we want the Government to come in and ensure markets for us, except to the extent that you are talking about export control issues, or you are talking about market access to R–1 trading partners, and to the extent that the United States can help to fix the markets, that would minimize the market risk issue.

The second area of risk is the financial risk which I think has already been discussed to a large extent. How do you finance certain R&D incentives by R&D tax credits and those kinds of things. Also included in that area would be something on the order of the Semitech kind of experience where seed money may be provided to assist a targeted high technology areas that are deemed to be part of this national agenda.

And then the third area, or fourth area of risk would be the whole legal risk issue which has to do with the tax law, the antitrust laws preventing consortiums and cooperative research activities which would be helpful in trying to move this along. In at least three of those cases, I do not think you are talking about dollars necessarily having to be spent. We are talking about Government action to assist in minimizing the risk that costs industry dollars for Federal regulations.

Senator KERRY. So on the second one, on the financial risk, you are saying that we should—are we talking about just the permanent and larger R&D tax credit? Are we talking about more than that? Industrial development bonds? What is the parameter of that?

Mr. TIRMAN. I am not sure what the parameter is. I think that the initial cut at this has to be the R&D tax credit because it is one where we can make some immediate—I mean, ITSL has 12.5 percent of its gross earnings into R&D, which is quite high even for our industry. That continued kind of encouragement makes it more attractive for us to put that money in there. But going so far as industrial bonds, et cetera, I am not sure how far to go on that.

Senator KERRY. Bob, how do you react to Russ' statement about the national agenda? Do you agree with that?

Mr. TIRMAN. Very similarly, because I think what Russell is saying is that the encompassing of all of those various technologies are embedded in what used to be called HDTV, and I like the better definition of "advanced visual system," which I wrote down, because it encompasses the telecommunications component, the communications component; it encompasses the computing component; it encompasses the display component; and it encompasses both the commercial, the governmental, and the end-user/consumer side of things. I think that is an excellent place to start, if you are going to define a national agenda in that area.

VOICE. It is a horse race on our strength, it leads to our strength, the digital thing.

Senator KERRY. Well, you know—I am the author of the legislation to change the antitrust laws to permit the collusion not just in the research but in development and manufacturing, and the biggest single problem that we have had has been MossBather at Commerce and the administration.

VOICE. Senator, I think it is helpful——

Senator KERRY. So if you folks can weigh in, I think it is important for them to be hearing from more business people on that subject.

Mitch, you have been waiting a bit. Russ, I will come right back to you.

Mr. KAPOR. I want to make a couple of observations.

The first is to second the notion that I do not think it is a question of whether the market serves industry or not. We do, we always have, and we probably always will. The biggest example is agriculture which we have targeted and supported for over a century with rather spectacular results. But we have an enormous problem in this country calling things what they are. We just do not like to call it that; we have to call it something else. I do not understand this, but it happens to be the way things work.

So I support the notion of somehow defusing the political debate about industrial policy—all this stuff about winners and losers—by calling it something else. OK? So I am in favor of having a national mission or an agenda, and I think it is a hell of a lot more relevant to people in terms of the standard and quality of living if it has something to do with electronics, and communications, and optical infrastructure, and all that, than a mission to Mars. That was great for the 1960's, but that is kind of a recycle.

But the challenge that I throw down to you, and I think if it is going to go anywhere in Washington, is it is has got to be about something more than the 21st Century Simpsons. I mean, it has got to have some vision to it. It has got to have some sort of value, some reason that we as a country should get excited about it the

way we got excited about sending a man to the Moon. I mean, make it up if you have to, but the idea of—and I would be happy to work on that. But my critique of it is that it just does not have a lot of pizzazz, "advanced visual systems," and it is not going to fly.

I think with some work, it could be turned into——

Senator KERRY. Let me let Russ comment, because I think Russ was aiming at something bigger than that. Why don't you jump on it.

Mr. NEWMAN. Let me accept Mitch's challenge enthusiastically. As you know, Mitch, at the Media Lab we have been trying to explore with prototypes things that might not be economically practical just yet——

Mr. KAPOR. With Japanese money, mostly.

Mr. NEWMAN. All right. If I could respond briefly to that——

[Laughter.]

Mr. KAPOR. It's not a criticism.

Mr. NEWMAN. The percentage of Japanese support of the Media Lab is something like 13 percent. So the relative portion of Japanese capital and support of R&D in this particular case turns out to be relatively small. That should not be the issue, the national origin of the capital that is used for research.

I think the issue should be this mixture—and a number of people have referred to it—this middle ground. I think, in fact, Mitch, you targeted it specifically. So that it is not the separation between R&D as some kind of very abstract research on very far out and not necessarily practical issues, but building within the educational infrastructure a concern about implementation and bringing products to market so that it does not somehow have to be a different agenda and you have to go to business school to get the second half of your degree if you are interested in bringing any of these theories to practical application.

I think the specific—and this is so important, and I take it as a response to Mitch's challenge—matter is what can we do collectively to make these abstractions of the information economy real I think is a pilot study, an extensive pilot study. I think the Japanese have done this extensively. I think we are going to see it more and more as a result of EC coordination of information in computers.

I suggest, just to pick one out of the hat, that Massachusetts and route 128 would make a very appropriate setting for a field study. NST might be one possible coordinating of bringing together the local, as Senator Kerry has us here for this discussion, bringing together some active, interested industries which would bring their own initiatives, ideas, and technologies to a field test of, and I would suggest, an optically based system, or perhaps a hybrid of optics, co-ax, satellites—General Instruments is very active in the satellite area—because they are interconnected.

And of course the core of the system is the switching, the manipulation and interpretation of data based on the high-speed computers. In Silicon Valley and in 128 and a few other places, I think particularly a rural application because I think a number of your colleagues in the Senate would respond very positively to taking seriously the notion that these kinds of electronics may have a very

differential and perhaps very positive effect on rural life and rural economics.

And this is a case where the involvement of the Government financially is to demonstrate feasibility and to jump start things. It is not picking winners in terms of specific technologies; it is picking winners in terms of goals. I think an advanced electronic infrastructure is a very worthy goal and very easily defensible, and the way to do it and to move fast is to do very serious field demonstrations and field tests in multiple sites.

Senator KERRY. How do you articulate the vision in a way that addresses what Mitch was saying about what you are really selling the American people? In other words, is it enough to say to the American people: You are going to get all this gadgetry in your home that is going to entitle you to do X, Y, and Z, and you are going to have bigger and better TV pictures? I mean, how do you frame it? I think I can find a way to frame it, but I want to understand how you would frame that "moon mission" in a way that captures the imagination for that agenda setting.

Mr. NEWMAN. I think I see it as an opportunity, as I said before, that our colleagues in Japan and Europe have invested billions of dollars in bringing us the 21st Century Simpsons. I think we have got an opportunity to do more and change television from just selecting one program from the 5 or 25 that are on your cable or broadcast spectrum, to a television which is not just entertainment, it is entertainment, information, whatever you want, because the number of channels available is 50,000, not 5 or 25; when the system can respond and say, well, I have been working on a paper in high school. I would like more information on the Outback in Australia. That information is on tape and in text files.

We have got a long way to go in developing the human interface so that somebody would understand that the information is there and would go to a video text system instead of an encyclopedia, and demonstrating that I think is the first step in motivating the private capital and in demonstrating that we can in fact leapfrog a very limited vision of advanced television that is currently being developed under the rubric of HDTV.

Senator KERRY. Yes, Mitch.

Mr. KERTZMAN. I think we are talking here about the difference probably between consumer marketing and leadership. The space program was not sold to the American public on the basis of the fact that each American would individually go to the moon. It was sold on the basis of national competitiveness and our country's stature in the world. I believe firmly that a universal optical system is the next step in that progression to make us the most competitive Nation on earth.

So I think that you cannot focus on the end consumer and what he or she is going to get in their living room as much as where we are going to be as a Nation. This addresses the issue of leadership, and I am struck with how often I get together with captains of industry and leaders of industry who in turn recognize leadership and look to the Government for the same thing.

I think we look at the problem with short-term thinking in this country. To me, the leading institution that epitomizes short-term thinking is Government which, at the House of Representatives

level, you know, the day after you are elected you are running for office again; the budget process, which is a 1-year to 1-year process; the Presidential election cycle. You have the luxury of sitting in perhaps the most patient institution that we have in Government. I think it is part of our problem here in State government, a lack of leadership.

And what we are talking about here is not really I think consumer marketing—that is a different issue; it is a matter of leadership. Leadership does not necessarily cost a lot of money. I am a big believer in the value of leadership—Presidential leadership, congressional leadership, tutorial leadership, and it is what we have precious little of.

A company that listens only to its existing customers with existing products rarely develops break-through technology. A Government that governs by opinion polls rarely produces an agenda and a mission of leadership, and that is the problem.

Senator KERRY. I agree with that. I think that is well stated. It is a good way to almost summarize. Let me come back to one other question before we do summarize a little bit.

Massachusetts. What else? We have touched on credit. We have touched on the tax credit, capital gains. We have touched on perhaps some security reform and a few other things. What are other ingredients, conceivably, of invigorating the creative high-tech or technology-oriented entrepreneurial skills and base that we have? Are there any other federal pieces of that puzzle that you want to suggest to the committee at this point in time?

Griff.

Mr. RESOR. I think that one idea that Russ brought up that I do not think should be left quite where he stopped, instead of prototyping this idea of K through 12 education that worked on Dr. Blackman's home study problem, you teach a whole generation of people skills that adults do not have. I was struck by a comment that the fellow from Data General made that when they first market-tested the lap tops, they picked top-level executives flying first class. What they learned is that top-level executives are computer illiterate. [Laughter.]

You might combine education and national agenda in this way—and it is also a much smaller focus of the problem to work with. I have a great fear that if you just put the terminals in people's houses, they would have no idea what to do with them. But that is sort of finishing up that idea.

Senator KERRY. Dave.

Mr. BLACKMAN. You have some very creative pieces that are already available by video systems of some in math and a lot in modern math by a gentleman at MIT. I worked with him a few years ago. We were putting together something called "Calculus" something?

VOICE. The Adena system? I do not know the name of it, but they certainly have been working in multiple forms of mathematics and calculus in the Adena system.

Mr. BLACKMAN. It is a relatively easy way to deliver those particular subjects that are now foreign in some schools.

Senator KERRY. OK. I think that is really a part of it.

Yes, Jackie.

Ms. BONNEAU. I think the other thing is that we have such a great higher education system in the State of Massachusetts. We have more universities per student than any other State. If you could tie into those universities and get your high school faculty and your elementary school faculty in there and get them excited about some of the things that we are discussing here, I think that that is going to filter down to those students so that we will end up with students at the end of high school being much more literate in all of the problems that we are discussing.

VOICE. I think what we are saying is that the 1990's are going to be a new war, and it requires education, industry, and the Government to work together to win this war. We've got to recognize that we are in a war.

Senator KERRY. Let me do this, if I may. Do you all have a copy of the legislation that I am introducing, which is an amendment to the Export Administration Act? It is called the Export Administration Reform Act of 1990. You do not have to look at it now, but you might want to take a peak at that.

It is sort of a first whack at much of what we have been talking about here. I think some good ideas have surfaced here, and we will probably want to think about them in the context of what we finally do when we get into this process in the committee.

But I think this has been very helpful. If I can sort of summarize:

On the export licensing we have had a recommendation of perhaps a super agency or some kind of independent entity that would streamline the process. I think that is a first and foremost priority expressed by everybody here. It must be simplified. It must be streamlined, and we have got to get our products into the market faster. That can happen by taking significantly more numbers of items off the restricted list and opening up the process with CoCom, and so forth. So that is number one.

Number two is the free license zones with the CoCom countries, the review of the control list, reviewing it fairly frequently, setting up a process so we are not caught behind the changes in technology; and that that is streamlined. And licensing of the system, rather than individual parts, so that you can move things out. I think that is a fairly quick summary, but I think those are good thoughts.

VOICE. In order to keep that updated, it seems to me you have to have the involvement of the private sector in that overview process, because that is where 90 percent of the information exists to determine at any moment in time what is a timely decision for a segment of technology. That is where the information exists, not in government.

Senator KERRY. Fair enough.

VOICE. Because it is moving so rapidly in business and in the trenches in developing technology, they know what is sensitive today and what has become obsolete in the last 18 months better than, on a current basis, any Government agency will ever know.

Sentor KERRY. The second area that we touched on was the whole area of R&D. There were the obvious comments about deficit, larger economic issues, and so forth, but tax credits, the R&D tax credit itself; conceivably tax credits for some kind of assistance

in terms of the math-science in secondary schools; the education issue, a significant focus on education as a whole and its linkage to this process. Grants for universities. Et cetera. Certain resource-oriented issues.

Then on R&D, capital gains; pension, mutual fund responsibility, and so forth. Commerce Department involvement in funding business; and antitrust reform, conceivably a pilot study or a DARPA, individualized commitments whether it is through the sematech type approach or other centers of excellence. We have four in Massachusetts. They are grossly underfunded. Clearly we ought to be accenting those kinds of efforts and really tying it into the concept of a national agenda on all of this. I think once you focus on that, a lot of these other things will flow.

I think that is a fairly tight summary of that, obviously.

I am impressed by the universality of frustration and the feeling that we continue to just hamper ourselves in more ways than one. I am going to take the record of this hearing and highlight some of the key comments and attribute them appropriately to each of you and make sure that each of my colleagues on both the Banking Committee and the Commerce Committee—because there is a dovetailing here obviously—get a sense of it. I think it has been very, very helpful.

There is no question in my mind that it is only a scratching of the surface of a number of these areas and issues, but far more helpful in this format than in the standard hearing format. I appreciate all of you taking the time to come and share this.

What I also want to do is to leave the record open for a short period of time so that if we want to follow up with staff in order to have you articulate clearly in writing, perhaps, a couple of the points here to just build on this record, I think that would be very, very helpful. I think if you were willing to do that, that would help supplement this so that as we go into export licensing reauthorization debates, as well as the other ones around this, HDTV, et cetera, that would be helpful——

VOICE. "Advanced Television."

Senator KERRY [continuing]. "Advanced television." You are right, and it is much more than HDTV. I do not disagree with that.

So on that note, unless somebody has some comment that they are dying to make that has not been made, or an observation that you would like to make in summary, we will stand adjourned.

I thank you all very, very much.

VOICE. Thank you.

Senator KERRY. I thank you.

[Whereupon, the hearing was adjourned.]

[The following dialogue takes place on the tape after the formal hearing:]

QUESTION. So are you saying that within the year we should see an open market?

Senator KERRY. I am saying that within the year we will see us put into law some of the things that will enable that to happen. The question of how fast it happens will depend on the Bush administration and the Commerce Secretary and Defense Department deciding to respond and implement those laws and get better at getting our folks into these other markets.

QUESTION. I am just wondering, have we already missed the boat because of the Government's restrictions; that these companies are so far behind that even if they are opened up now, there are other competitors out there who are ahead of them?

Senator KERRY. In some disciplines, that would be true. But broadly speaking, no. There is a huge marketplace out there, and there are an awful lot of products that we could sell. There are boats yet to be missed, conceivably, but hopefully this legislation is going to get us out there into a position where we are really able to do what we know how to do best, which is to put our creative genius to work, put our capital to work, create new jobs, and get out into the marketplace and win. And we can do it in ways that are environmentally friendly and sensitive, that help deal with less developed nations' problems, and that really create a whole new vision of what the future can be like.

I think it is very exciting, and a lot of it depends on the government being more cooperative in its efforts with industry and opening up those opportunities.

QUESTION. Thank you, very much.

Senator KERRY. Thanks. I appreciate it.

Today I set forth a new piece of legislation which is going to help Massachusetts' citizens be able to find new jobs, or to expand our already existing job base. What I am trying to do is guarantee that when we have products that are made in Massachusetts, we are not going to restrain them from getting into the marketplace in other countries.

We have been shooting ourselves in the foot too much, and the result is that too many people in Massachusetts have lost jobs as a result of it. My bill is going to guarantee that if we create products here, we are going to be able to get those products out into the world marketplace, and we are going to be able to expand without losing countless days and even years as a result of government bureaucracy blocking those products from getting out there.

I think people are frustrated and angry and tired of it, and I think this piece of legislation is something that can really do something positive to keep people working and to expand our job base.

[The tape labeled "tape 3" ends at this point.]

[The prepared statement of Dean David C. Blackman follows:]

# The Northeastern Comprehensive Regional Center for Minorities in Science and Technology

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## Overview

Of the many facets to the problem of underrepresentation of minorities in science and technology, the Center will initially throw its weight toward an Urban Science Academy, its goal being to send minority students to post-secondary colleges and universities in a position to do full-scale undergraduate science and mathematics courses **without remedial assistance**.

The Urban Science Academy will draw on and expand, or establish

- coalitions among the institutions to bring their expertise, influence, resources, and opportunities to bear on the preparation of elementary, middle, and high school students in mathematics and science
- vitally enhanced coursework in mathematics and science, including algebra for middle school students and pre-calculus for high school students
- extensive in-service and additional training and development for teachers in mathematics and science
- curricula and equipment adequate for teaching mathematics and science appropriate to contemporary applications.

The Center will initially comprise a core consortium of schools--Northeastern University, the Center's base; North Shore Community College;

Roxbury Community College; Bunker Hill Community College; and the Boston and Cambridge Public School Systems. Participating organizations will include the Biotechnology Process Engineering Center of MIT, and the Educational Technology Center of the Harvard Graduate School of Education. Its prospects for expansion include Boston University, and the University of Massachusetts at Amherst and Boston.

The Center will act from inception as a hub for coordinated activities based on interaction between the central consortium of institutions and others committed to our developmental goals. Industries--Polaroid, Digital Equipment Corporation, AT&T, Corning Glass Works, and Lotus Development Corporation among them--will contribute apprenticeships, mentoring programs, prospective career role models, and equipment and material to Urban Science Academy students and other Center participants. College recruitment, preparation, and inter-institution transfer will profit from the contributions of programs under the Center's umbrella such as NUPRIME, Pre-NUPRIME, and Project Interlock.

Family and community involvement through outreach programs involving Greater Boston resources such as the Museum of Science and the Children's Museum are part of a strategy to nurture, encourage, and motivate students within the context of science experiences to raise the exposure and retention levels of minority students in science, mathematics, engineering and technology.

Boston has a target minority population of over two hundred thousand students and is part of the American heartland of science and technology. A Comprehensive Regional Center is a catalyst and focal point for institutions, industry and community, teachers, students and families to redress the imbalance in minority representation in science, mathematics, engineering, and technology.

Target School Systems
Boston Public Schools
Cambridge Public Schools

2-Year & 4-Year Colleges
Northeastern University
Roxbury Community College
Bunker Hill Community College
North Shore Community
College

Organizationa and Institutions
Educational Technology Center
The Algebra Project
Cambridge Partnershjip
Boston Community
Organizations
The Efficacy Institute
Industry

Years 2 - 5
Expansion

YEAR 1: CORE CONSORTIUM OF INSTITUTIONS

## I. Introduction

The **mission** of the Northeast Regional Center is to spearhead the development of programs to increase the numbers of minorities in technical and scientific professions by creating partnerships among colleges and universities, schools, the minority community, business, and government.

The **dominant focus** of the Northeastern Regional Center for Minorities in Science and Technology will be to prepare young minority men and women students to enter undergraduate programs in science and mathematics **without need for remediation**. A considerable portion of the Center's emphasis will be on the pre-college components of the broad coalition of programs.

It is neither desirable nor necessary, however, to focus on pre-college students to the exclusion of other groups--teachers, undergraduates, community resources, and industry--that need to be included in a healthy, broad-reaching, thorough, and self-perpetuating Center. All these groups are **integrated in the Center's activities** and contribute to and profit from the array of programs for which the Center is hub and coordinator.

The **approach** the Center proposes for achieving these goals reaches deeply into the first-year target schools--the Boston and Cambridge Public Schools. The approach

- is grounded on programs with proven track records
- draws together constituency groups desirous of working together
- will build on a shared commitment to these goals and objectives.

The Center is committed to these goals for students:

- taking a leadership role in encouraging, motivating, and nurturing minority students
- developing cooperative activities to improve pre-college science, mathematics, and engineering education
- stimulating efforts to coordinate and facilitate the transition of minorities from high school to college status, transfer students between institutions, and retain minority students in their programs of study

- enhancing the potential for a stable, long-term continuation of Center activities beyond the grant funding period.

The institutions and organizations comprising the Regional Center, with Northeastern at its hub, are experienced in understanding and addressing the problems minority students face. They are committed to a cooperating network of programs involving schools, colleges, universities, industry, and the community. We need funding to give our solutions an impact adequate to the scope of the problem.

### Snapshot: Genesis of the Center's Thrust

We went to the schools first to understand their needs. We talked with Mary Lou McGrath, Superintendent of the Cambridge Public Schools, and the staff of the mathematics and science departments. We talked with Joyce Grant, Assistant Superintendent of Curriculum, of the Boston Public Schools; Joe Aranjeo, Headmaster of Boston Technical High School which is the pilot school for Center programs in the Boston system; and the heads o the mathematics and science departments at boston Tech. People were clear about the dominant needs they felt: teacher development from elementary through high school to reach students throughout the system, and programs to extend learning beyond the class day for students in all ranges of achievement.

"Our primary aim in the years of funding from the National Science Foundation is to send minority students into college level science and mathematics programs without need for remediation. We are working toward a goal of 200 - 500 students a year from the Boston and Cambridge Public Schools with that level of preparation. We have Center programs to support and advance students in two- and four-year colleges as well, but we intend to build a very strong pre-college foundation of study."

"Starting with the school systems themselves was critical to our strategy. We believe that the most successful approach to increasing minority students in the pipeline to careers in science and technology should and does lie within the schools, not as an adjunct to them. We needed the cooperation of school personnel across some

traditional divisions. By building agreements and a proposal that responded to their needs, we got more than cooperation from the people in the school systems -- we got enthusiasm, commitment, and our dominant source of recruitment for the programs reaching beyond the school day."

"Not every student will need each program the Center is supporting. We are weaving together programs that will reach students and teachers at different points of need and achievement. We know that programs with dedicated staff and hands-on experience are most successful with our target audiences."

"We have drawn together knowledgeable and qualified people--Judah Schwartz and Stone Wiske from the Education Technology Center at Harvard's Graduate School of Education, for example, and Don Wise from our Biology Department here at Northeastern--and the Center's group of participants has the resources and wherewithal to achieve the goals we have set."

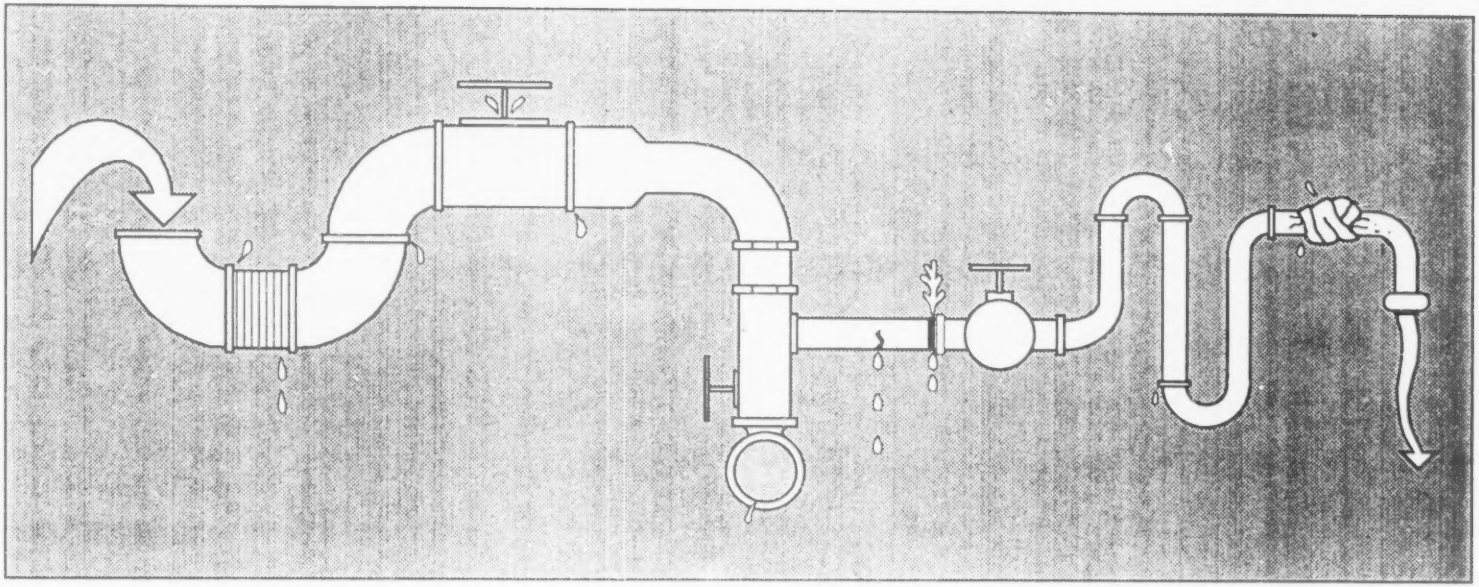
"Those are the large issues--skill, knowledge, resources, and commitment. But we also have the micro-organization we need. We lose students when they cannot put together the package of support they need, when they cannot hold together the right courses, the necessary job, the financial support. That's how I can serve, and the Center's staff can. We can answer the questions, we can weave and hold together the web of support. We can keep students in the Center, pump them through the pipeline, into the professions."

--David Blackman, Principle Investigator for the Center

## II. Problems: Leakage In The Science And Technology Pipeline

The on-going difficult state of public elementary and high school education in this country; the disparity of opportunity between minority peoples and non-minority; and the shortage of educated and skilled workers in science, mathematics, and technology are agreed to form the increasingly pressing need to develop, increase, and improve programs for minorities at all academic levels in science, mathematics, and technology.

## Problems: Leakage from the Pipeline



**Elementary School**
- Instruction by transmission
- De-emphasis on science
- Tracking
- Emphasis on testing
- Underprepared teachers
- Low expectations

**Middle & High School**
- Summer learning loss
- Negative peer pressure
- Unaligned sequence of study
- Lack of vision of success
- Out-of-school issues and concerns
- Difficult transition to college

**2-Year & 4-Year Colleges**
- Inadequate pre-college preparation
- Difficulties studying while holding job
- Absence of role models
- Barriers to transfer from 2-year to 4-year programs of study

New England is a region with rich and notable academic offerings. But the minority population here shares the familiar disadvantages in preparation, opportunity, and support that hurt and frustrate minority groups in regions less renowned for their schools and universities. The audience we wish to reach with a Regional Center for Minorities is not adequately approached or served by the wealth of institutions around it.

Northeastern University is exceptional in its efforts and determination to address the minority population and offer it education in science, mathematics, and technology. Its NUPRIME program for minority students in engineering is an important foundation program for the kinds of efforts the Regional Center will make to reach and help students, and NUPRIME's leadership is experienced and dynamic. Northeastern has historic links of academic opportunity with the minority population in Boston, particularly its home neighborhood, Roxbury. It has, through its classic Co-op Program, critically important links to industry. But even Northeastern's success is not as great as the need.

Institutions interested in and able to join Northeastern in a Regional Center--institutions including public schools and two-year colleges--are now typically isolated in their efforts to prepare and support minorities in science and technology education. Their efforts are pronounced and successful, but again, not in proportion to need.

The need for excellence in science, mathematics, and technology is not unique to our region or minority people. But clearly the effort to create greater opportunity, better preparation, and enhanced support in education will have its effect student by student, institution by institution, community by community. Successes centered on our target population in our region could be replicated broadly; the problems and disadvantages we intend to address are representative.

National Discrepancies in Academic Accomplishment

We face the prospect of demographic factors conspiring to increase the distance between our national needs for people trained in mathematics, science, and engineering and the success of the population we have to fill them.

The nation's attention has been increasingly focused on three areas of discrepancy in academic accomplishment in science and mathematics:

- the low ranking of American students' performance in mathematics and science on international scales of achievement
- the markedly poorer representation of women and non-Asian minorities at each higher academic level of mathematics or science, and in industry
- the population-wide shortage of labor adequately skilled for the mathematic, scientific, and engineering demands of the American workplace presently and into the decade.

In New England

The discrepancies are acute in New England, ironically so given New England's status as a region of high personal income and excellent academic institutions. The affluence of New England is non-minority affluence--

- the median income for a White New England family was $36,984 in 1987
- the Black family median income was 74 percent of that
- the Hispanic family median income was $13,346, only 36 percent of White family income

--and the link between socioeconomic factors and academic performance is widely recognized:

> Students enrolled in advanced high school mathematics courses come disproportionately from White upper- and middle-class families. Differences in culture and parental expectation magnified by differential opportunities to learn imposed by twelve years of multiple tracked classes produce vastly different evidence of mathematical power.

Blacks and Hispanics make up 6.2 percent of New England's population, and a higher percentage of its youth, but are weakly represented in higher education--while the rate for all high school dropouts is 25 percent, the rate for Blacks and Hispanics is 50 percent. Meanwhile, 95 percent of baccalaureate, master and doctoral degrees in mathematics, physics, and engineering go to non-minorities. And selective New England institutions

largely recruit the minorities in their programs from outside the region.

The demographics in New England are changing, as they are nationally. The young minority population is growing. In the 1990s, 30 percent of public school children will be minority students and by the end of the decade only 15 percent of new entrants to the workforce will be non-minority males. Yet the patterns of education look backward rather than forward.

## Focus: The Problem at the Elementary School Level

When they start school, young children do not need extra motivation to find science and mathematics engaging; they are curious about and responsive to the phenomena of their world. But the pipeline carrying students to careers in mathematics, science, and technology springs its first leaks at the elementary education level.

### Problems for Students

Currently children tend to have to wait too long to see what "doing science" means--they lack hands-on experience and exposure to stimulating mathematics and science--and they lose their early enthusiasm. Some young students change their focus of interest to other subject areas and slip out of the science and technology pipeline early. Others lose their enthusiasm more generally for learning for reasons that follow.

### Problems of Instruction

The emphasis in instructional modes at the elementary level, particularly in mathematics and science, has been on **transmitting information** held by teachers to students, rather than on constructing problems and finding solutions to them. In the face of an emphasis on test answers as a measure of knowledge, transmission appears to be an efficient mode for communicating introductory level content.

Proponents of sound pedagogy do not agree. They find transmission to be a cause of long-standing misinformation held by children. They find that it is an instructional mode that does not address the differing ways students

register and integrate information. They find that the passive experience of receiving transmitted information frequently diminishes motivation and enthusiasm for learning.

The method of instruction in science and mathematics is problematic for the learning process for many students. But in learning science the difficulty is heightened because there is **very little science instruction** in most elementary school programs.

The early application of **ability grouping** is perniciously problematic for minority students. Decisions made about young students based on differing rates of preparation for learning can segregate students on a low-level educational track for their entire academic lives.

The emphasis on **evaluative testing**, sometimes more politically than pedagogically motivated, can act as a catalyst for other weaknesses of instruction. The transmission mode of instruction and tracking lend themselves to standard tests for measuring progress. The construction mode, flexible pacing, and cooperative learning do not, or do so less easily.

### Snapshot: Approach to Solution

> The Teacher Advisor Program is designed to respond by helping teachers change the emphasis in the classroom from students answering questions about science and mathematics to formulating them. Cooperative learning, particularly effective with minority students, will replace transmission as the dominant mode of learning.

### Problems for Teachers

Problems for teachers fall into three general categories:

- lack of knowledge in mathematics and science
- lack of skill in different teaching modes and strategies
- beliefs that do not contribute to and indeed can undermine, students' academic success.

The pronounced shortage of teachers in mathematics and science--less than ten percent of the nation's elementary school teachers of mathematics

meet present professional standards for teaching mathematics (Connors, 1988)--has been compensated for, in part, by reassigning minimally qualified teachers, or by enlarging classes. Teachers are aware of their underpreparation and are reluctant to stray from assigned texts and formulaic problem-solving. Problems are perpetuated for minimally prepared students by uninspiring and unrealistic experiences of mathematics and science.

Boston-area elementary school teachers and administrators themselves see the problems of underpreparation:

- budgets restricted by Proposition 2 1/2 create a **dearth of in-service development** for those teachers who want to enhance their skills
- **the sense of isolation** in the classroom is more pronounced when teachers are teaching in their areas of weakness: generally educated elementary school teachers place an underemphasis on science; minimally qualified mathematics teachers fall back on their own experience of mathematics, and so continue a classic misemphasis in mathematics--on calculation rather than numeracy
- the current national emphasis on test results **skews teaching toward test-taking** as an end

Consistently, minimally qualified teachers recognize that they lack experience **in scientific and mathematical thinking** and so underemphasize it in their students' experience.

The problem of **beliefs held by teachers that can inhibit student success** is not unique to teachers. Students themselves and their families can have low expectations for their success. But the reinforcement of low expectation, or the introduction of it, clearly undermines the prospect of effective education. The problem is increased, though it is not created, by cultural differences between teacher and student. The ratio of minority teachers to students is very low nationally.

Problems of Context

Minority and poor students particularly suffer from **disjunctions between home and school**. The serious problems for students from homes of poverty and hopelessness are ubiquitously known. They affect the

elementary school student at every level of life, two of which are appropriate to this discussion. The absence of an education legacy in the home can influence student and family expectations and contribute to the formulation of discouraging teacher beliefs. And the gap in preparation for the transition from home to school can be much larger than that for students from families in higher socio-economic conditions, with higher expectations and greater successful experience of education. In a system that practices early evaluative testing or ability grouping, the larger gap is an added disadvantage to the student.

## Focus: The Problem at the Middle and High School Levels

Some of the weaknesses of elementary school education facing minority students, particularly weaknesses in science and mathematics, persist into the middle school years, and some increase with a vengeance. **Tracking** begun in elementary grades, for example, becomes a self-fulfilling process as students directed to less rigorous coursework find themselves increasingly distant from their better educated, more challenged peers. The problem of **summer learning loss**, which one estimate puts at 80 percent of the difference in learning between advantaged and disadvantaged students, builds as year after year some students suffer it more than others. For these older pre-college students, however, there are **new problems** as well.

### Problems for Students

The power of **peer pressure** is at its most telling for middle and high school students. For minority students particularly, peer pressure at this age is rarely constructive of good academic skills and aspirations. Black and Hispanics who strive for academic success may be derided as "acting White." Girls drop away from mathematics and science beginning in the sixth and seventh grades in response to the pervasive message that "girls can't do" mathematics or science. And most American middle and high school students, minorities heavily included, practice "nerd aversion," preventing them from expressing enthusiasm for learning mathematics and science.

The desire for acceptance by the group at this age is so strong that peer

pressure of this kind would alone be a strong deterrent from succeeding at mathematics and science. But for minority students it is not alone. Many minority students, lacking role models and a legacy of academic involvement, also lack a vision of success for themselves in those fields. They have not been taught, picked up, or developed effective study skills, so the task of mastering increasingly complex subject matter is exceptionally daunting and fraught with real or potential failure. Those who are persisting in their studies often study alone.

**Snapshot: Approach to Solution**

> The Urban Science Academy is the Center's core group of programs supporting students. Its programs extend from in-school, to after-school, to summer activities bolstering and enriching students' experience of mathematics and science. The Urban Science Academy programs draw teachers, university researchers, and industry professionals together with students in a diverse web of activities that make the work of mathematics and science stimulating and relevant.

Problems of Instruction

At the secondary school level, academic tracking can actively prevent students from meeting preparation requirements for college. More generally the sequence of study in science and mathematics is out of alignment with the requirements of college work in those fields, as curricula that diverge from the recommendations of the National Science Teachers Association and the National Council of Teachers of Mathematics demonstrate.

The problems of instruction by transmission are familiar, first described in this proposal as a problem at the elementary level, but in middle and high school, courses are more rigidly discrete and information transmitted about algebra, for example, is even less likely to be integrated with information from any other area of a student's experience.

The divergence between schooling in mathematics and science and their application in college and the professions is enlarged by underequipment in laboratories and classrooms, and by inadequate integration of computers in curricula when computers are available.

Problems for Teachers

Less than half of America's 200,000 secondary school teachers of mathematics meet present professional standards for teaching mathematics. Underprepared teachers recognize a **divergence between the high school curriculum they are prepared to teach and the preparation their students need for college mathematics and science**, and between school teaching of mathematics and science and real world applications.

Problems of **lack of subject knowledge and lack of pedagogic knowledge** that face teachers at the elementary level persist here. As the academic experience of students goes on, the difference in their levels of achievement that reflect encouragement or its lack, out-of-school enrichment or its lack, academic support in the home or its lack, and other factors that distinguish advantaged from disadvantaged students increase. Teachers' general beliefs about ability and probability of success also persist at the middle and high school level and appear to find confirmation as they become self-fulfilled prophesies.

Problems of Context

In New England, as in the nation, minority students are concentrated in urban areas. The most **dramatic problems for at-risk minority students of middle and high school age occur out of school**, in the larger society of their communities. The problems are familiar from tabloid and screen: disrupted homes and the strains of poverty; the distance and suspicion offered by much of the non-minority community; the initial ease and allure of substance abuse or dealing; the boy threatened, attacked, and recruited by one gang or another; the girl seeking status and affection by childbearing.

If problems of this magnitude set the context for filtering middle and high school age minority students out of the pipeline for careers in science and technology, concern for that loss seems minor, a quibble by comparison. We consider that it is not. The out-of-school problems are enormous and severe for many. But schools and learning could be powerfully positive off-setting experiences.

## Focus: Problems at the Undergraduate Level

Nationally, leakage from the mathematics, science, engineering, and technology career pipeline for minorities at the undergraduate level arises principally from factors we have considered above and some that are particular to this level:

- **inadequate pre-college preparation** for college level courses in mathematics and science
- **difficulties holding more than a half-time job** and maintaining good standing in their coursework
- extremely **limited presence of minority faculty**, mentors, and role models
- **difficulty transferring** from two-year community college programs to baccalaureate programs.

### Problems of Preparation

The problem of underpreparation for mathematics, science, and engineering courses at the college level is exacerbated for minority students for well and widely documented reasons:

- their **concentration in urban schools** with relatively weaker curricula and chronic shortages of qualified mathematics and science teachers
- **low expectations for their success** by teachers, themselves, and others
- a tendency to be **shunted away from rigorous college preparatory courses**.

Many New England colleges and universities are highly competitive, and while they may admit a portion of each class with weaker preparation than the majority, the coursework itself is an effective winnowing process. Remedial help is generally available, but students with **underdeveloped study skills** often have difficulty profiting from it.

## Snapshot: Approach to Solution

**The programs of the Urban Science Academy extend to students through the college level. Recruitment and support programs have been powerfully effective--with NUPRIME, the minority retention rate in Northeastern's School of Engineering surpassed the non-minority retention rate. Project Interlock defeats the barriers to transfer between two- and four-year colleges, and builds bridges instead.**

Financial Problems

The background characteristics associated with low socioeconomic status--from low parental expectations, to undernourishment and poor study habits--that contribute to difficulties for minorities at the undergraduate level are familiar from this proposal and elsewhere. But the most consistent finding concerning financial factors is that **holding a full-time job while in college undermines persistence and achievement**. Loans can be as effective a deterrent to a college education as they can be an incentive: Students from low income families often have family support as one of their regular financial demands. The prospect of entering the workforce with loans to repay in addition to regular financial demands can be an overwhelmingly negative one.

Problems of Models for Success

Role models can cast long shadows: Students who are statistically at a disadvantage can influence their destinies favorably by emulating examples that contradict the statistical norm. But **role models for minorities are extremely hard to find** at the undergraduate level. In a 1987 study, the Massachusetts Institute for Social and Economical Research found, without exception in the cases they studied, minority-student-to-minority-teacher ratios much higher than white-student-to-white-teacher ratios--sometimes by a magnitude of 20.

Where there are instructors in the classroom who are minorities, the condition of mathematics and science study in the United States today adds

an unusual dimension to minority college teachers as role models in those fields. **Graduate student teaching assistants are foreign nationals** with increasing predominance, particularly in mathematics and engineering. Currently

- 75 percent of graduate students receiving financial support from university engineering departments are foreign nationals
- fewer than half the mathematics doctorates awarded by US universities go to US citizens
- the number of US doctorates in mathematics has dropped nearly 50 percent over the last decade.

The teaching assistants' strengths in mathematics and engineering are offset by lack of experience in teaching; frequently by difficulty empathizing with American undergraduates; and too often by fundamental problems of communication, culturally and linguistically, with students.

Problems of Articulation

Barriers to transfers of credits between two-year and four-year institutions and the difficulty of simultaneously holding a full-time job and persisting to a baccalaureate degree are the dominant factors in leakage from the pipeline of minority undergraduate students who begin study in two-year colleges.

In New England, as in the nation, **Black and Hispanic undergraduates are concentrated in two-year colleges**--more than half of their enrollment in public campuses is in two-year college programs for good reason:

- tuition is significantly lower than four-year programs
- commuting from home to a local two-year college is financially more feasible than living at a four-year campus
- two-year colleges emphasize courses scheduled around the regular workday.

While nearly 75 percent of two-year college students declare they wish to transfer to a four-year institution to continue their studies, only 15 percent on average do.

## III. The New England Regional Center's Approaches To Solutions

**The pipeline of minorities entering the workforce in mathematics, science, engineering, and technology has serious leakages at several junctures from Kindergarten through the undergraduate level, for reasons we have described. The intention of the Center for Minorities is to work to close the leaks along the length of the pipeline** in a web of programs involving schools, colleges and universities, industry, and the community.

### Program Goals

The central spoke of the Center umbrella, its central concern and focus, is the **Urban Science Academy**, the spoke comprising the instructional and motivation activities connecting all the work of the Center to its primary target audience--minority students in mathematics, science, and engineering. The Urban Science Academy represents the heart of our initial goal: to **send minority and women students to post-secondary colleges and universities in a position to do full-scale undergraduate science and mathematics courses without remedial assistance**.

The Boston Public Schools with 58.2% of its enrollment Black, Hispanic, or Native American, and the Cambridge Public Schools with a 50.1% minority student body are the Urban Science Academy pilot schools for its programs to increase the presence of minorities in careers in mathematics, science, engineering, and technology. Teachers from these schools will form the focus of the initial teacher development aspect of the Center's programs.

For students in two-year or four year college programs of study, particularly students at risk, the Center has projects to **develop and strengthen institutional capabilities** for supporting and retaining minorities in undergraduate mathematics, science, and engineering. It has programs to facilitate the transition of minority students from high school to college status, and to smooth transfer between institutions, particularly between two- and four-year programs of study.

The Center recognizes the advantages of extra-curricular enrichment for

all students. But it believes the most useful, consistent, and lasting efforts at educational development should be integral to schools, not outside of them. For this reason, with cooperation and critical contributions from school teachers and administrators, the Center proposes a broadly encompassing program of development for students and teachers in mathematics and science based on nationally and locally recognized needs and concerns.

## Program Staff and Advisory Committee

The key program personnel have the experience, skills, training, and expertise to implement the Center's programs successfully, and they are committed to doing so. Program Director David Blackman, Dean and Director of Minority Affairs, will report to President John Curry. Dean Blackman has been involved in the education of minorities for 15 years and will be responsible for directing and overseeing the implementation of the Center's programs.

Dean Blackman will be assisted as Program Director by an Executive Committee from cooperating institutions and organizations who will oversee programs pertinent to them and who, together with the Program Director, will develop plans, implement strategies, and evaluate programs. They are

- Mary Lou McGrath, Superintendent, Cambridge Public Schools
- Joyce Grant, Assistant Superintendent of Curriculum, Boston Public Schools
- Sandra Spooner, Assistant Superintendent for Curriculum and Instruction, Cambridge Public Schools
- Donald Wise, Cabot Professor of Engineering, Northeastern University
- Dr. Alan Sheppard, Vice President of Academic Affairs, Roxbury Community College
- Kathleen Assar, Ed.D., Vice President of Academic and Student Affairs, Bunker Hill Community College
- David Wharton, Director of Student Outreach, North Shore Community College
- Judah Schwartz and Marthe Stone Wiske, Education Technology Center, Harvard Graduate School of Education

- Robert Moses, The Algebra Project
- Alan Dyson, Executive Director, The Cambridge Partnership

The National Advisory Committee will contribute program reviews, reports, and recommendations for program improvement to the Center. The National Advisory Committee will also operate as an initial liaison group between the New England Regional Center and others across the nation. Members are

- Franklin Jennifer, Chancellor, Massachusetts Board of Reagents
- Paul Grey, President, Massachusetts Institute of Technology
- Daniel Wang, Ph.D., Chevron Professor of Engineering, Director, Biotechnology Process Engineering Center, Massachusetts Institute of Technology
- John Williams, Harvard Graduate School of Education
- Philip Uri Treisman, EM Lang Visiting Professor, Swarthmore College
- C.A. Dana, University of California at Berkeley
- George R. Brewster, Manager, College Relations and Recruiting, Corning Glass
- Robert E. Maurer, Ph.D., Head, Hybrid IC Process Engineering and Development Department.

Specific Initial Objectives

Elementary Level

Minority children, city children and poor children particularly, need hands-on experience and exposure to stimulating mathematics and science. The Urban Science Academy's approach to elementary school children focuses on **increasing experience and exposure, in school and out.**

Fundamentally, Center member institutions, organizations, and teachers want to **change the emphasis from answering questions in science and mathematics to formulating questions,** and in a way that leads to series of discoveries so children starting in elementary school begin to understand what doing science means.

This point of emphasis will be addressed by programs like the **Advisor Teacher Program**, placing an immediate focus on **rapid and vigorous enhancement of skills** for present mathematics and science teachers to increase their subject knowledge, and pedagogic knowledge and skills; to diminish their sense of isolation with their areas of weakness; and to diminish the misplaced emphasis on basics and heighten emphasis on mathematic and scientific thinking.

The second dominant goal the Center holds for elementary school students is to **engage students early** in science and mathematics through programs integrated with the excellent **community resources in the metropolitan Boston area**, and to engage their parents as well.

These programs **integrating outside resources with schools** will begin to make a more permeable membrane between school experience and the science and mathematics of the larger world. Children will experience learning science and numeracy as formulating a question, working through answers with scientific methods, and sharing answers as real world scientists do.

Middle and High School Level

The goal of **preparing all middle school students to take pre-college mathematics courses in high school** is an acknowledgement that calculus is the gateway from high school to college mathematics, and that undergraduate mathematics is the underpinning for all the sciences. Underpreparation or lack of success in courses leading to undergraduate mathematics precludes a successful transition to higher level mathematics or science. The **Algebra Project** is the Center's program for preparing teachers to teach and students to learn, within the public school system, algebra in the middle school grades.

The Urban Science Academy's Saturday Program and the Summer Study programs will address simultaneously many of the disadvantages interfering with academic interest and success in mathematics and science for minority students:

- the **pernicious effects** of ability grouping in lower grades and of summer learning loss
- **social pressures** to avoid science and mathematics or to do barely adequate schoolwork

- problems of **self-doubt, low expectations, and lack of vision of success**
- the **misalignment** of high school mathematics and science curricula with college coursework.

The programs will create **intensive, enriched learning** for students at all levels. They will create more interaction between institutions and organizations, bringing university specialists and industry scientists and engineers together with pre-college teachers and students. The **mentoring** aspects of the Saturday and Summer programs, in which older students or more advanced students teach younger, lower level students, increase learning and self-esteem on both sides.

The goals of the Saturday and Summer programs will be carried further by the **Thirteenth Year** program, in which high school graduates needing more work before encountering the demands of freshman courses in science and mathematics can take coursework in colleges and universities for a term or a year and then enter the formal undergraduate course of study. A sister program will give well-prepared and interested high school seniors a spring quarter of coursework in science and mathematics at Northeastern.

Programs like Pre-NUPRIME, Masschusetts Pre-Engineering Program, and What is Engineering? address these Center goals:

- to **broaden understanding** among students, parents, teachers, and counselors of the diversity and opportunities for science and engineering careers
- to encourage, prepare and support students to undertake **challenging high school study** in science and mathematics, and go on to undergraduate and postgraduate study, and to careers in science and engineering
- to create pertinent **role models** for minority students in science and engineering by introducing and working with professionals who use science and mathematics in their occupations
- to **create links between occupations in science and mathematics and classroom curricula** and to help students make the link between interest in science and mathematics and potential occupations.

A Center goal is **equitable representation of men and women minority students** in programs of study, and in careers in science and mathematics.



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Recognizing that middle and high school age girls face extra discouragement in pursuing an interest in science or mathematics, we have designed programs to enhance their anticipation of success. They will be open to and will help boys as well. These are group experience programs, variants on the executive training and wilderness experiences so successful in building trust, confidence, and teamwork.

The **Parallel Co-op** program will address the Center's goal of creating **apprenticeship and internship experiences** in science, mathematics, or engineering in industry for minority high school students like the Co-op experience Northeastern undergraduates have.

The Urban Science Academy will have a **central physical space** at Northeastern University to house programs, projects, and equipment for participants and will use space in participating institutions as well. The goal of equipping high school science classrooms with computers, LCD pads, and software to allow for recording, displaying, and analyzing laboratory data, and equipping mathematics classrooms to allow students to use technology to investigate, conjecture, and verify their findings, will be met initially in the Urban Science Academy classrooms. The Center is working to establish an **Equipment Bank** to provide participating high schools with the hardware and software to convert their classrooms to science and mathematics laboratories in similar fashion.

Undergraduate Level

The three dominant goals the Center holds for science and mathematics study by minority students at the undergraduate level are

- to help them, with **academic coaching**, make up any discrepancies between their pre-college preparation in mathematics and science and the demands undergraduate coursework makes upon them
- to provide **work study programs** that enhance students' academic study with concrete experience in the professional workplace, and that ease the financial burdens of higher education
- to **facilitate the transition for minority students between institutions**--from high school to college and from two- to four-year institutions.

The Center's approach to the first two goals is represented by models currently offered at Northeastern University. Northeastern University Progress for Minorities in Engineering (**NUPRIME**) is a sixteen-year-old program for recruiting, supporting, and retaining minority students in the School of Engineering. Northeastern's **Co-op Program** is the historic model for blending study with work experience in regional industry, often forming a link to full-time postgraduate employment.

**Project Interlock**, pioneered by North Shore Community College, a Center participating institution, is the model program breaking down barriers to transfer often faced by minority students beginning their undergraduate studies in two-year colleges and wishing to continue to the baccalaureate in a four-year program.

Teaching at the Pre-College Level

To **stanch leakage around pre-college teaching in the pipeline to mathematics and science careers for minorities**, the Center's goals are

- to draw skilled and dedicated mathematics and science teachers to the elementary, middle, and high school classrooms
- to provide diversified resources for teachers and students
- to encourage shifting the emphasis from teacher presentation of material (transmission) to guided learning (construction).

## IV. Resource Center Activities

The Center will grow to serve as the hub for activities on the national, regional, and local level. **Nationally** it will join the web of Regional Centers and work to disseminate successful programs throughout the country. **Regionally** it will expand to embrace more school systems, institutions, and industry involvement. It will begin, however, on the **local level** with programs reaching minority students and their families in communities in the Metropolitan Boston area. The schools, institutions, and industries initially committed to Center activities are in that area as well.

## The Urban Science Academy

The heart of the Center's activities addressed to students is the Urban Science Academy. The work and involvement of the Center goes beyond the Urban Science Academy--relations with other Regional Centers, with member institutions, with industry--but all programs working directly with the target audience to increase the presence and progress of minorities in the science, mathematics, and technology pipeline come under the Urban Science Academy arm of the Center.

The **physical space** for the Urban Science Academy will be at Northeastern University and throughout the network of participating institutions. The Center is currently applying to the Apple Foundation and will draw further on industry support to **supply equipment for mathematics and science classrooms** there and in Boston and Cambridge schools. Students need the technical tools for the contemporary, real world approach to science that their new curricula supports. Computers, scientific calculators, LCD panels, and software will transform classrooms into laboratories for student-centered learning. Nearby **access to Center-affiliated university professionals**, and **telecommunications access** through Network Northeastern to a rich array of programs, give students support and an enormously expanded universe of mathematics and science experience.

The Urban Science Academy programs are designed for students from elementary through undergraduate level and are intended to address the problems and achieve the goals outlined in this proposal. They span students' needs both in and out of school.

## Urban Science Academy Summer Program

The Urban Science Academy Summer Program will recruit and serve both students and teachers. The activities for each of the two groups will be separate but will have constructive overlap.

The Urban Science Academy Summer Program will address important

needs and goals:

- reversing the problem of summer learning loss to increasing learning between school years
- instituting peer and cross-age tutoring among students
- involving teachers in 12-month academic years, and giving them more effective instructional strategies and heightened enthusiasm and knowledge of mathematics and science.

The Summer Program will run for six weeks of the summer school recess, four days of the week. The initial phase-in year will focus on students in grades nine and ten. Ninth grade teachers will join the program the first year, seventh and eighth grade teachers will be included the next.

Northeastern University has experience and success with summer programs on which to build, including the Balfour Academy, What is Engineering? and STEP programs.

What Is Engineering?

In 1977 Northeastern developed one of the first summer institutes designed to provide high school students with

- a broad exposure to elements of the engineering profession
- exploration of the mathematical, computer, and scientific skills engineers use
- experience of what it is like to be in college.

The What Is Engineering? Summer Institute is a two-week residential program for 25 rising senior minority students from New England south to Washington DC, students with peak interest in exploring college and career choices.

The heart of the program is seminars and workshops balanced among mathematics, computer use, introduction to engineering, and college orientation. Field trips for first-hand views of engineering projects and the engineering workplace, and cultural and recreational activities to heighten comraderie and the quality of a visit to Boston are additional essential components of the program. Follow-up of past participants show that almost



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all go on to attend college and 50-75 percent enter engineering-related programs.

As is customary for minority programs at Northeastern, the What is Engineering? Summer Institute is financed jointly by the University and industry, in this case by the American Society of Civil Engineers, the ASCE local section, and local engineering firms.

## The Urban Science Academy After School and Saturday Programs

After school and Saturday programs are addressed to minority students, parents, and teachers and draw on the resources of the larger community. Northeastern University presently sponsors effective after school and Saturday programs described below. The Center will expand them to add an on-site elementary school program and to include extended programs with museums and other Boston community science resources.

Some of the after school and Saturday projects will include students and teachers learning together. In those cases, the teachers' component will extend to include pre-project and post-project sessions with Center staff around the project topic to expand teacher knowledge and skills in teaching as well as topic knowledge. After school and Saturday programs will be led by strong and enthusiastic high school instructors of science and mathematics.

### Museum Programs

The Harvard Museum of Comparative Zoology; Museum Institute for Teaching Science (MITS), representing nine science museums in the metropolitan Boston area; and Community Outreach Services of the Museum of Science (COSMOS), a physical science program for children K-six, are groups under the Center's umbrella offering extended experience with science for elementary students. The coordination between the rich community offerings of the area, schools, and community organizations will draw children into experiences they may not have in families uncomfortable in predominantly non-minority middle-class milieux or unaccustomed to close involvement with children's schoolwork.

The Center-related museums have also prepared programs to help

teachers at the elementary level draw on museums as part of their curriculum. Their scientific expertise is available and valuable as teacher development and as a direct resource for students.

Interaction with Professors and Professionals

The **Visiting Scientist** program will draw four minority scientists, mathematicians, or engineers representing a range of ages and career patterns to the Center to be in residence and available to students and faculty through lectures, seminars, and individual consultations. This is an involvement of industry in Center activities that goes beyond financial support, however interested. The loan of IBM engineer and physicist Dr. Daniel Smith as coordinator of academic services for NUPRIME reflected the same industry involvement.

The University of Lowell's **Kids Network** lets children talk with experts via computer, and NUPRIME's **Physics Intuition Program** begins in elementary school and continues through high school, helping children with such concepts as appreciating sizes, volumes, surface areas, masses, and weights of objects from the astronomically large to the subnuclear small and how those quantities are measured; what other kinds of quantities--energy, momentum, wavelengths--there are and how they are measured; understanding ordinary phenomena like rainbows, sunrise, and seasons; and how common machines, electronic gadgets, and electrical equipment work.

These programs, integrating outside resources with schools, will begin to **make a more permeable membrane** between school experience and the science and mathematics of the larger world. Children will experience learning science and numeracy as formulating a question, working through answers with scientific methods, and sharing answers as real world scientists do.

For example, Professor Donald Wise at Northeastern is designing a **Biotech Engineering Center** for Northeastern to focus on innovative, practical, product-oriented solutions to societal needs--like finding an inexpensive way to produce acetic acid as a non-corrosive alternative to road salt. He is committed to teaching by doing and coaching, and will offer his thinking on approaches to practical engineering to high school students through the Urban Science Academy.

Confidence-, Team-, and Trust-Building

The richness of the academic opportunities described above may not themselves transform into enthusiastic mathematicians and scientists present high school students, particularly girls and minorities with histories of self-doubt, experience with low expectations, and social pressure to avoid mathematics and science. Those hurdles are high. The Center and the schools will offer, through the Urban Science Academy, variants on the **executive training and wilderness experiences** so successful in building trust, confidence, and teamwork. The Urban Science Academy variants will integrate science experiments with the wilderness expereinces.

The Center will also **train high school students in trust-building and leadership skills** so they can act as facilitators in student-centered instruction activities. **Mentoring** is central to the Center's thinking on building links between practicing scientists and mathematicians, college professors, teachers, and students. Students will work as actively in the helper mentoring role as in the helped. **Older students will be working with younger** as mentors and role models, being trained, for example, in specific zoo- or aquarium-related topics, taught individually or as teams to work with elementary students on the material, and then going as a group to Franklin Park Zoo or the New England Aquarium for field experience.

> Any student at any level can come to the Urban Science Academy and be directed correctly through the Academy's network of programs and resources for help or experience. **Outreach and recruitment** in the metropolitan Boston community will be part of the Urban Science Academy program--students most lacking in motivation, self-confidence, and expectation are least likely to bring themselves spontaneously to the Urban Science Academy.

Programs range from preparing students to enter science fairs, to pairing students and professional role models to learn about careers, to providing work experiences in labs or field research sites including local hospital and university laboratories and the Woods Hole Oceanographic Institute.

The programs below are presently in place, open to students after school. They have been the proving ground for the projects aimed at the needs and

goals for students in this component of the Center's undertaking.

Pre-NUPRIME

Pre-NUPRIME is designed to improve the pre-college preparation for engineering of minority students in the Boston-Cambridge and Marion-Buzzards Bay areas, to improve the educational quality of mathematics and science programs in the secondary schools, and to increase the number of motivated and qualified minority students from Boston-Cambridge and the Cape Cod area who enter engineering school each year. Its first year, 1977, the Boston program helped 26 students; this year 260 are involved. The Cape Cod Pre-NUPRIME is fully supported by Sippican, Inc. and has grown steadily since its inception in 1979.

Enrollment has soared in both Pre-NUPRIME programs. The Boston program, now in its third and final year of funding by the GTE Foundation, currently enrolls 60 high school students, triple last year's number. Designed to stimulate interest in science and technology careers, the program involves weekly mathematics workshops, field trips, and social activities, with a special focus this year on a lecture/demonstration series by a senior faculty member on biotechnological solutions to environmental problems.

Pre-NUPRIME's in-school and after school programs include

- hands-on independent and group science and technical research projects involving real-world problems susceptible to engineering solutions, like the dump students are working with
- students informed and participating in university research projects
- career education and exposure, including field trips to labs, research centers, and manufacturing facilities
- role models as speakers and mentors
- mathematics and science competitions
- academic counseling and tutoring and studyskills assistance in science and mathematics
- awards and incentives programs.

Biotechnology Special Institute

A classic example of Northeastern's pivotal role in drawing University programs, industry, and local schools together around education in science and technology is the Biotechnology Special Institute under the direction of Donald Wise, PhD, Cabot Professor of Engineering at Northeastern.

The Institute's pilot program began as a thirteen-week after-school series of lectures on Applications of Biotechnology by volunteers from the Engineering faculty for 25 10th grade minority students identified by NUPRIME from local high schools. It was completed by 20 students, a record retention rate for extra-curricular programs of this kind. The second pilot program expanded to include 64 9th and 10th grade students from Boston Latin School, and to comprise two afternoon sessions a week for thirteen weeks.

Six of the applicants initially expressed interest in a career in science or engineering; at the end of the program only six indicated they were not interested. Of the 52 students who completed the program, 15 applied for a 4-week summer internship program to work on a research topic with one of the session presenters. Two-thirds of the 90 participants in the two pilots were minority students.

The Biotechnology Special Institute is now creating a program to develop and test curricula in modern biotechnology and its applications for use in high school classes and laboratories by building on its pilot program experience to bring together high school teachers, an interdisciplinary group of university professors, and industrialists who are experts in areas of biotechlology to plan the curricula. The university faculty and high school teachers, and selected qualified industrialists, will work together with high school students during the academic year.

MassPEP

In addition to its own Pre-NUPRIME program, Northeastern has been an active partner in the Massachusetts Pre-Engineering Program for Minorities (MassPEP) since its inception in 1978. MassPEP is based at Wentworth Institute of Technology next door to Northeastern University and works with leading Greater Boston business and community organizations, the Boston and Cambridge public school systems, and other university schools of engineering to

- interest minority students, male and female, in grades seven through twelve in pursuing careers in engineering
- develop improved programs better able to prepare minority students to gain entrance to engineering colleges and technical institutions
- assure coordinated educational, community, and business support for pre-engineering programs.

In 1988, 360 students participated in MassPEP's high school program. High School site teams comprise four members: a coordinator, a science teacher, a mathematics teacher, and a computer teacher. Each student completes a science or technical project over the course of the academic year, and emphasis in project design is placed on interdisciplinary applications of mathematics, science, and computer skills and concepts.

Internships and Apprenticeships

Students in their later high school years are not likely to continue in the Urban Science Academy Summer Program because they will need and want to work in summer jobs for income and experience. To keep them in the science and mathematics pipeline, the Center will expand on Northeastern University's Coop Program and the Boston Compact models to include high school students in the opportunities for work in industry in useful fields of study.

> Boston is an area rich in precedents for this kind of industry-academy reciprocity. The historic strength and reach of Northeastern University's Co-op Program is at the heart of the integration of industry involvement in the Center. That involvement is important to the success of several program elements involving career information, industry resources, and links between academic experience and the workplace. Ultimately more important, however, is that the existing links between Northeastern, the home institution of the Center, and industry breach the customary barrier to continuing programs beyond the funding period--on-going financial support.

The Co-op program, ongoing support for Pre-NUPRIME and NUPRIME all reflect the existing involvement between industry and academic science, mathematics, and engineering in Boston and New England.

Expanded Co-op Programs

The Center proposes to export the co-op model to other participating institutions with conditions conducive to setting up graduate intern options in mathematics and science. The Dreyfus Foundation gave Northeastern a one-year grant to promote graduate cooperative education, and the work begun with that grant will be pursued by the Center.

Parallel Co-op

Parallel Co-op is a program providing relevant career experience and opportunity for minority and low-income graduate students in engineering. Parallel Co-op does not alternate work and study on a quarterly basis. Cooperating employers hire students to work one full day and four mornings a week, full time in summer, and students' academic programs are arranged for afternoons and evenings four days a week. Salaries two-thirds of those of practicing engineers are justified, and experience with cooperating firms has demonstrated the success of this arrangement.

Internships

Under the Internship Program, cooperative firms develop a package of tuition and a stipend offered to qualifying minority graduate students of engineering who, if they are agreeable, work at the firm for 18-24 months in return for the financial package.

Thirteenth Year

The Thirteenth Year Program is designed for minority students who have graduated from high school but who still need work to bring their knowledge and skills in areas of science and mathematics to the level of undergraduate coursework in those fields. It will permit them to enroll in college courses suited to their knowledge and skill levels and then be admitted to the regular freshman level as they are prepared. They will not be

filtered out by a competitive winnowing after they have come so far, but will be supported and encouraged in their work.

A sister program will give well prepared and interested high school seniors a spring quarter of undergraduate coursework in science and mathematics at Northeastern.

Transition Programs

An important focus of Center activity is in overcoming barriers to transition between institutions--high school to college, two-year to four year colleges--that have been powerful filters, shutting minority students out of the science and technology pipeline. The consortium of colleges and universities in the Center will work actively to offset the problems undergraduate minority students face by offering

- **academic coaching** at all levels
- **work study programs** for financially burdened students
- an articulated, effective **system of transfer** between two- and four-year institutions in the Center.

In-House Special Assistance Programs

In-house, Northeastern has a body of assistance programs that have given us both occasion for experimentation and a sturdy history of success in designing and implementing methods to help minority students enter and stay in science and engineering programs of study. We will draw on our experience with in-house programs as we design and evaluate projects for the Regional Center.

NUPRIME

Over the last fifteen years, through a program called Northeastern University Progress in Minorities in Engineering (NUPRIME), the number of Blacks, Hispanics, and Native Americans enrolled in engineering at Northeastern has increased from 14 in 1974, NUPRIME's first year, to 283 students in 1988-89. According to fall enrollments reported by the Engineering Manpower commission of the Engineers Joint Council,

Northeastern enrolls more Blacks in engineering than any other independent institution of higher education in the nation, exclusive of two predominantly Black institutions, comprising 18 percent of all blacks attending four-year institutions in Massachusetts.

NUPRIME began as the University's direct response to the national call to increase minority representation in engineering. Through the recruitment of minority students with an interest in and aptitude for engineering; and the provision of adequate financial aid, tutorial and remedial programs and counseling services; the University has substantially advanced its goal of increased minority representation.

In 1988 NUPRIME provided 950 hours of one-on-one tutoring in mathematics and science subjects for minority students. Summer quarter 1989 students had additional tutorial aid in mathematics through the video series "Calculus Revisited" provided by the Center for Advanced Engineering Study at MIT. The video series continues as one part of an extensive program of workshops and tutorials in core subjects. And NUPRIME provides $90,000 in supplementary student financial aid annually, mostly from corporate contributions to the program.

NUPRIME's 1989 statistics speak to the consistent success of the program:

- of the 248 students that are currently involved in NUPRIME, 132 or 59%, are from the greater Boston area
- a record 38 minority students--12.7% of the engineering graduating class--graduated in June, bringing the total of alumni served by the program to 251
- a record 283 minority students were enrolled in the 1988 fall academic quarter--79 were freshmen, nearly 12 percent of the entering class
- the 1988-89 retention rate reached 93 percent, a higher retention rate than the College of Engineering's as a whole.

Part of the 1987-88 success was a result of the coordination of academics and industry characteristic of Northeastern's approach to education. Dr. Daniel Smith, coordinator of NUPRIME academic services, is a Black physicist and engineer on loan to NUPRIME from IBM. NUPRIME is the longest running privately funded program at the University, now in its fifteenth year.

Work Study Programs

Northeastern's classic Co-op Program is an American success story in allowing students to study and work simultaneously in job placements that enhance their career opportunities. The same studies that show full-time jobs undermining an undergraduate's likelihood of persisting to a baccalaureate degree demonstrate that part-time work facilitates that persistence. The Center has replicated the concept of the Co-op program in many of its expanded work study programs.

Articulation Programs

Project Interlock, pioneered by Center participating institution North Shore Community College, is the model program addressing the barriers to transfer faced by minority students beginning their undergraduate studies in two-year colleges and wishing to continue in four-year programs.

Project Interlock admits students simultaneously to the engineering program of a two-year college and a four-year institution. Because the two-year college provides smaller classes, intensive tutorial support, and strong personal support, the transfer from high school to college will be relatively smooth. Collaboration between faculty at the two-year colleges and the four-year schools will provide a tightly integrated, coherent, and continuous curriculum giving students a smooth transition between lower division engineering at the two-year college and upper division studies at the four-year institution. Motivation for completing the baccalaureate degree gets powerful assistance from the program, and bureaucratic barriers are absent. The participating institutions are linked by the MBTA system, making access to them feasible.

## Teacher Development Programs

The Center recognizes the advantages of extra-curricular enrichment for all students. But it believes the most useful, consistent, and lasting efforts at educational development should be integral to schools, not outside of them. For this reason, with cooperation and critical contributions from school teachers and administrators, the Center proposes a broadly encompassing

program of development for mathematics and science teachers currently in the classrooms, based on nationally and on locally recognized needs and concerns.

Teacher Advisor Program

The essence of effective in-service teacher development is to accomplish the integration of effective innovations with the practical wisdom that veteran teachers' already possess. We propose to develop and support a cadre of Teacher Advisors as the key ingredient in building this connection. Teacher Advisors will be recruited from the ranks of those teachers in the Boston and Cambridge schools who are already effective in helping minority students learn mathematics or science. Through their participation in the Center these Teacher Advisors will first strengthen their own teaching by incorporating new materials and practices into their own classroom. Then, with Center support, they will work closely with other teachers to extend and share their knowledge.

Teacher Advisors will need to enhance their knowledge and skills in three areas: (1) increased subject matter knowledge and pedagogical knowledge to improve their own teaching of mathematics or science, (2) effective strategies for enhancing learning of minority students, (3) knowledge and skills for providing effective professional development experiences for other teachers. They need firm grounding in current methods and materials for teaching mathematics and science, including the integration of new technologies and the "hands on/minds on" approaches that both mathematics and science educators heartily endorse. They need to understand the special challenges that minority students may face in their quest for academic achievement and strategies for helping students meet these challenges. Finally, they need to know how to design and conduct effective workshops with teachers, and to follow up these experiences with sustained opportunities for collegial exchange and support.

Research on the process of implementing new curricula and instructional approaches suggests that there are at least five dimensions of change: changes in materials, structure, role/behavior, knowledge and understanding, and value internalization. Teachers who are asked to

incorporate significantly new practices into their classroom need more than materials and training in how to use them. They also need opportunities to confront, consider, and solve problems that arise as they attempt to integrate the innovation into their classroom. Staff development research has indicated the value of coaching, that is extended opportunities to practice new behaviors while a more experienced teacher observes and offers feedback. Through such experiences teachers not only acquire new knowledge, and practice new skills, but also engage in the slow press of reconsidering their belief about knowledge, about the process of teaching, and about the capabilities of their students, and the roles of teachers and learners.

We envision Teacher Advisors similar to those prepared by Lappan et al. in their National Science Foundation-funded middle grades mathematics project. They distinguish the role of coach from that of advisor in that advisors work alongside teachers as partners. They not only offer advice, but actually assist the teacher in preparing curriculum, designing lessons, occasionally modeling reaching approaches, and otherwise alleviating the burdens of innovative teaching. Their ultimate task is not just to support the development of skills, but to help teachers develop a problem-solving and reflective attitude.

The Harvard Educational Technology Center (ETC) will direct the Teacher Advisor Program as a way of linking resources from the educational research and development world with those of the target school systems. ETC conducts research on effective strategies for teaching mathematics and science in the schools and for supporting the integration of such innovations into regular school settings. ETC successfully developed a Teacher Advisor model in its laboratory site schools where successive generations of Teacher Advisors first integrated innovations into their own classrooms and then extended innovations to colleagues within and beyond their own schools. In consultation with the Center Co-Directors ETC will oversee recruitment and development of Advisor Teachers. These teachers will be introduced to new methods of teaching mathematics and science, as well as receiving support for working effectively with minority students.

In providing education and support for teachers, ETC will draw on the resources of its own collaborative research projects as well as those of others. We will review the many excellent materials that have already been

developed for improving mathematics and science education, several with NSF funding. Our local area is rich with organizations which develop such innovations. We will consult with Education Development Center, Bolt, Baranek and Newman, Technical Education Research Centers, and the National Center for Improving Science Education, based at The Network in Andover, Massachusetts. All of these organizations are engaged in developing curriculum and strategies for enhancing science and mathematics instruction.

A group of Teacher Advisors will attend a four-week summer workshop during the first year. We will attempt to include teachers whose students are also participating in the Center's summer, after-school, and Saturday programs. Throughout the subsequent year they will incorporate methods and materials from the workshop into their own classes. During the year they will meet regularly with each other and with Center staff to support and reflect on this experience as they plan ways of extending this effort to a wider circle of teachers. On-site consultations will supplement these regular meetings as a way both to monitor the results of Teacher Advisors and to provide assistance.

We anticipate that an additional group of teachers will be recruited to attend a workshop with Teacher Advisors during the summer of Year 2. Center staff will continue to meet with Teacher Advisors throughout Year 2. Their discussions will include all three topics described above (i.e. science and mathematics teaching, ways of supporting minority students' learning, and teacher development strategies) but the emphasis will shift in the second year toward the latter topic. On-site consultations with Teacher Advisors and at least some of the teachers they are working with will serve to document the impact of the program and provide formative feedback. Additional resources will be supplied to address difficulties that Teacher Advisors and their teacher partners encounter.

Harvard Educational Technology Center

The Educational Technology Center was established in 1983 at the Harvard Graduate School of Education to study ways of improving mathematics, science, and computing education with new technologies.

Formed as a consortium, including school districts, educational research and development institutions, and media production organizations, the Center supports collaborative research groups. These groups include subject matter specialists, cognitive scientists, curriculum and educational technology designers, and experienced teachers. Each group focuses on a particular "target of difficulty," an important topic in the curriculum known to present problems to teachers and learners. They analyze what students need to learn, the reasons for students' difficulties, and effective ways of improving teaching and learning. They design and test experimental materials and approaches using new information technologies as well as traditional curriculum. These efforts have led to the development and implementation of several innovative instructional projects that use new technologies to improve teaching for understanding through guided inquiry.

Over the years the Educational Technology Center has developed an effective approach to school/university collaboration. Teachers join university-based personnel from the beginning of projects intended to link the fruits of educational research to the improvement of eduction in schools. With their combined expertise they design and carry out activities that meet several criteria: careful attention to subject matter, use of recent research on effective teaching and learning, and consideration of the practical realities of school and classroom settings. Their efforts integrate systematic research, development of effective methods and materials, and support for sustained integration of new approaches into regular school settings.

The scope of work on this project will take advantage of ETC's knowledge both of effective ways of improving science education and of supporting the integration of these innovations into a range of school settings. The work will include the following tasks:

- Participate on the National Advisory Group and play a key role in planning and monitoring the Northeastern Regional Center's agenda.
- Review the scientific and educational quality of activities offered to teachers and students through the Urban Science Academy.
- Responsibility for coordinating all educational services for teachers and students.

- Design and direct the Teacher Advisor Program and other staff development activities.

The Efficacy Institute

Jeff Howard of Efficacy Institute has developed his Efficacy Model of human intellectual development based on his belief that as long as students are confident when they start learning, they can use "effective effort" and develop more intelligence. His view runs counter to the national tendency to track students by decisions about innate intelligence. Nationally, on tests of academic performance, Howard says, "we have seen consistently a 3- or 4-to-1 ratio for blacks to whites at the bottom of the performance scale." But Howard points out that the Israelis and the Japanese are teaching calculus to every high school student in their systems.

Following Efficacy methods. the number of black students getting A's and B's in Wayland High School doubled, and the number of black students getting D's and F's was halved. In Detroit, where Efficacy principles have been taught in public schools since 1982, standard achievement test scores have risen.

The Center can offer teacher development in the Efficacy methods to improve the effects teachers' expectations have on their teaching, as well as passing along to students through teachers, new expectations about their own skill at learning.

The Algebra Project

The Algebra Project is a four year pilot project taking place in three of Boston's public middle schools. The Dearborn, King and Lewenberg Schools are participating in this project.

The Algebra Project is based on the assumption that all students can and should learn algebra. At each participating school, all sixth graders will study the Transition Curriculum, designed by the Algebra Project to help students make the transition from arithmetic to algebra. When they reach the seventh and eighth grades, they will study algebra. The goal of the project is to prepare each student to enter Honors Algebra or Geometry in the ninth grade. At a minimum, all students will be prepared to study Algebra I in the ninth grade.

The Algebra Project also will use the Efficacy Curriculum, developed by the Efficacy Institute. The curriculum focuses on teaching students the process of development: "the process of building identity, character, analytic and operational capability, and self-confidence." At some schools, the Efficacy Curriculum will be taught by Algebra Project teachers. At others, teachers other than the Algebra Project teachers will teach this curriculum.

The Algebra Project is committed to empowering teachers and parents to participate actively in the project. Not only are teachers preparing to teach new materials, they are learning a new approach to teaching; one based on the model of facilitating students' learning rather than imparting knowledge. Teachers have participated in 40 hours of training to prepare for the project. In addition, they will attend monthly group sessions to discuss the project's progress and help chart its course. At each school, teachers in the project are involved in policy making for the project. And, teachers will be involved in the development of homework assignments to accompany the text.

Parents will be represented in the policy making bodies. Further, discussions are underway about developing a class for parents who would like to work through the curriculum.

Teacher and Administrator Support and Enthusiasm

Teachers and administrators in the Boston and Cambridge public schools believe strongly in the Center's linkage and umbrella approach--that pre-college programs should be woven into the fabric of schools, not isolated efforts. Their willingness to engage deeply in the Center's efforts is reflected in their suggestions for teacher development programs. They want more and regular access to specialists in mathematics and science, to well-developed materials, and ongoing support. They want in-service training in successful programs and funds to purchase program materials. They have asked for staff development activities to train and coach teachers in effectively establishing, using, and maintaining cooperative learning models as a way to improve teaching and learning.

Telecommunications Networks

Teacher development is an area in which the richness of New England

resources and the commitment of organizations and institutions to the Regional Center for Minorities in Science and Technology is particularly apparent. **Network Northeastern** is a microwave-based broadcast carrier system incorporating a telephone talk-back system that can serve as a base for disseminating teacher development programs throughout the region, and beyond it, via the National Technological University (NTU) Satellite Network. Network Northeastern makes communication between experts in the field, academic experts, and pre-college teachers logistically easy and accessible and will be an important link between the Center and its web of teacher development programs.

The **Massachusetts Corporation for Educational Telecommunications** (MCET) is a public corporation established by the Commonwealth to create and operate a statewide distance learning network. MCET will provide telecommunications support in conjunction with Network Northeastern as the Center's reach expands.

## Programs and Targets

| | Who | | | What | | | | | When | | | Funding | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Students | Teachers | Indus./Comm. | Enrichment | Apprenticeship | Remediation | Recruitment | Articulation | In school | After school | Summer | NSF funded | Non-funded | Partial funded |
| **Elementary School** | | | | | | | | | | | | | | |
| Museum of Science | ✓ | ✓ | ✓ | ✓ | | | | | ✓ | ✓ | | | | |
| Museum Institute for Teaching Science | ✓ | ✓✓ | ✓ | ✓✓ | | | | | ✓✓ | ✓ | ✓ | | | ✓ |
| Advisor Teacher Program | | ✓✓ | | | | | | | ✓✓ | | ✓ | ✓✓ | | |
| Visiting Scientist Program | ✓✓ | | ✓ | | | | | | ✓✓ | | | ✓✓ | | |
| Algebra Project | ✓✓ | ✓ | | ✓ | | | | | ✓✓ | | | ✓✓ | | |
| **Middle & High School** | | | | | | | | | | | | | | |
| Museum Insititute for Teaching Science | ✓ | ✓✓ | ✓ | ✓✓ | | | | | ✓✓ | ✓ | | | | |
| Advisor Teacher Program | | ✓✓ | | ✓✓ | | | | | ✓✓ | | ✓✓ | ✓✓ | | ✓ |
| Visiting Scientist Program | ✓✓ | | ✓ | | | | | | ✓✓ | | | ✓✓ | | |
| Urban Science Academy | ✓✓ | ✓ | | ✓✓ | | ✓✓ | | | | ✓✓ | ✓ | | | |
| PrePrime | ✓✓ | | | ✓✓ | | ✓✓ | ✓ | | | ✓✓ | | | | |
| Biotech Science Institute | ✓✓ | ✓ | | ✓✓ | | | | | ✓ | | | | | |
| MassPEP | ✓✓ | | | ✓✓ | | ✓ | ✓ | | | ✓✓ | | | | |
| Thirteenth Year | ✓✓ | | | ✓✓ | | | | ✓ | ✓✓ | | | ✓✓ | | ✓ |
| Algebra Project | ✓ | ✓ | | ✓✓ | | | | | ✓✓ | | | ✓✓ | | |
| **Two-Year College** | | | | | | | | | | | | | | |
| Thirteenth Year | ✓✓ | | | ✓ | | | | ✓✓ | ✓✓ | | | ✓✓ | | |
| Project Interlock | ✓✓ | | | | | | | ✓✓ | | | | | | |
| **Undergraduate** | | | | | | | | | | | | | | |
| NUPRIME | ✓✓ | | | ✓ | ✓✓ | ✓ | ✓ | ✓ | ✓ | ✓✓ | ✓✓ | ✓ | ✓ | ✓ |
| Expanded Co-op | ✓✓ | ✓✓ | | | | | | | | | | | | |
| Visiting Science Program | ✓ | ✓ | | | | | | | ✓ | | | ✓ | | |

## V. The Center's Consortium Of Institutions And Organizations

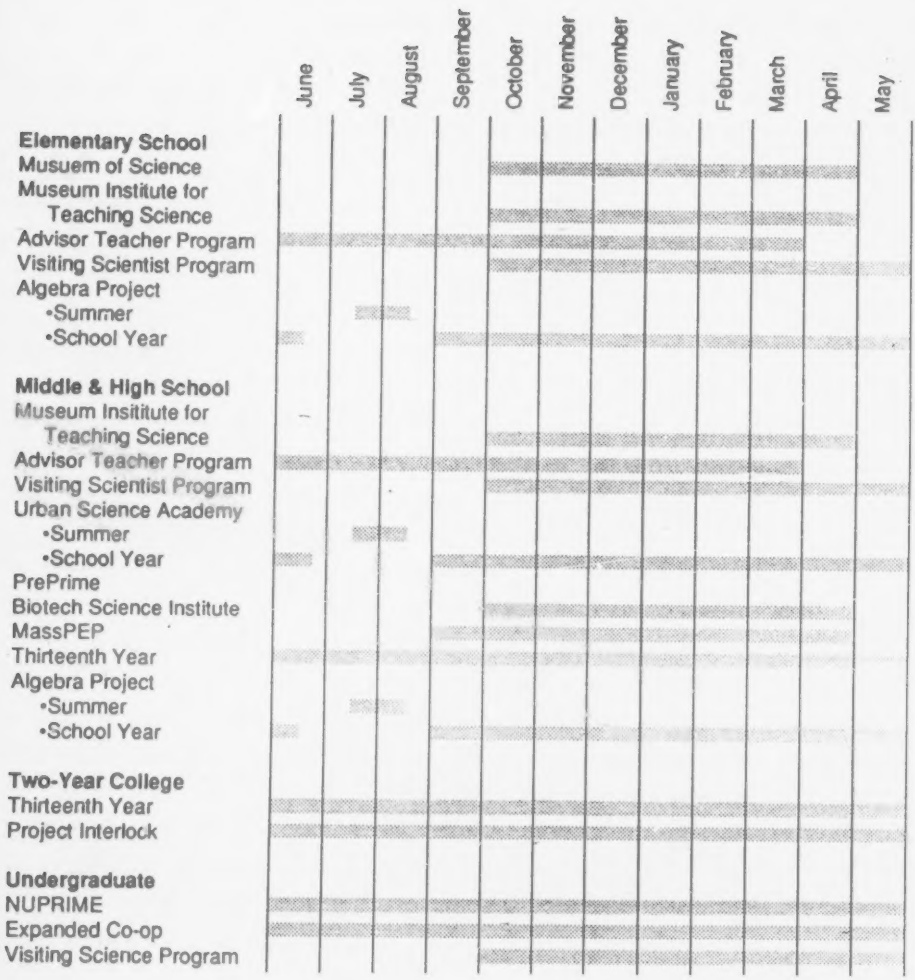
The institutions and organizations comprising the Center will weave programs together, forming a web to reach, attract, and support minority students at all levels of study in mathematics and science. The serviceability of the Center will be greater than the sum of its parts--programs will not remain discrete in their separate native institutions but will merge together under the aegis of the Center to reach and serve more people than they could separately.

Institutions and organizations will have more permeable membranes than they have in the past. Articulation between two-year and four-year colleges and universities, for example, will allow movement to participants that has previously been restricted. The services and support of university and industry mathematicians, scientists, and engineers for teachers will reach beyond those teachers to students in classrooms whose learning will be enhanced by teachers and specialists alike. The distinctions between community resources--museums, zoos, arboreta--and schools will become blurred for students as museums become classrooms and practicing scientists come into the Urban Science Academy.

Each of the institutions or organizations joining to form the Center as it is initiated bring strengths from the outset. Each academic institution is easily accessible by public transportation to participants linked to any other institution. The flexibility of program design and enactment is significantly heightened by that ease of accessibility. As the Center grows and expands, some physical accessibility will be lost, to be replaced by powerful telecommunications networks.

The institutions presented below form the Center's initial core consortium. As the Center expands, prospects for inclusion are Brandeis University, Boston College, Boston University, University of Massachusetts at Amherst, and University of Massachusetts at Boston at the university level, and a widening circle of schools and organizations addressing students at every point in the science and technology pipeline.

**Time Line**


June
July
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September
October
November
December
January
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March
April
May
Elementary School
Musuem of Science
Museum Institute for Teaching Science
Advisor Teacher Program
Visiting Scientist Program
Algebra Project
•Summer
•School Year
Middle & High School
Museum Insititute for Teaching Science
Advisor Teacher Program
Visiting Scientist Program
Urban Science Academy
•Summer
•School Year
PrePrime
Biotech Science Institute
MassPEP
Thirteenth Year
Algebra Project
•Summer
•School Year
Two-Year College
Thirteenth Year
Project Interlock
Undergraduate
NUPRIME
Expanded Co-op
Visiting Science Program

## Year 1 Participating Institutions and Organizations

### Northeastern University: Base for the Regional Center

**Northeastern University is uniquely qualified** to function as the seat of a Northeastern Regional Center for career access opportunities in science, mathematics, and engineering. Not only is it located in Boston, the city with the largest minority population in New England, it is physically **within the predominantly minority Roxbury district** from which many of the participants in Center programs will come.

The residents of Roxbury, Northeastern's neighborhood, constitute the largest concentration of minority peoples in New England. Of Roxbury's population of 38,911, 93.1% is minority compared to 30.1% for Boston as a whole. Of this minority population, 42% is 18 years old or younger and 25% is below the Federal poverty level: Roxbury has a median income of $10,510.

**Northeastern University's Program for Minorities in Engineering (NUPRIME)** is representative of Northeastern's commitment to successful experience developing and preparing minority students in mathematics, science, and technology. NUPRIME, in its 16th year, hasa director experienced in the needs, tasks, and solutions that are the foundation of the Center's activity. It has historic links to the target audience--traditionally one-third of the students entering NUPRIME have come from the Boston Public School System. Through the Co-op program and special linkage programs for NUPRIME and its pre-college sister program, Pre-NUPRIME, NUPRIME has working partnerships and a functioning network of local and regional contacts in education, industry, and government with which to underpin support for the programs of a Regional Center.

Northeastern is the physical home base of the Center and the Urban Science Academy. It will house Center offices, classrooms, equipment, and a telecommunications base, and will be the hub of Center activities.

### Roxbury Community College

Neighbor to Northeastern, Roxbury Community College is most intimately placed to reach and attract the Center's target population of students. Community outreach programs are part of Roxbury's rich tradition

of service to Boston minorities. Presently, of Roxbury's 2468 students, 75 percent are Black, Hispanic, and American Indian.

Bunker Hill Community College

Bunker Hill is another natural feeder into engineering baccalaureate programs and has a growing number of articulation agreements with area colleges. It has one of the largest honors programs of any community college in the region for academically talented students who choose Bunker Hill for its lower tuition and are then increasingly motivated when they arrive. Bunker Hill has a longstanding commitment to work with elementary and high school students in Boston, Charlestown, Chelsea, and Somerville that targets minority students particularly. Twenty-one percent of Bunker Hill's 6456 students are Black, Hispanic, or American Indian.

North Shore Community College

North Shore connects participants in downtown Boston and Cambridge with industries along Massachusetts' Technology Corridor on Route 128. North Shore brings experience with Project Funnel, a summer enrichment program for minority high school students making a transition to post-secondary education, and Project Interlock, a program to select, support, and transfer minority men and women to baccalaureate engineering programs.

Boston Public Schools and Cambridge Public Schools

The dominant goal of the Urban Science Academy is to prepare students to go on to college-level courses without need for remediation. The Boston and Cambridge Public School systems are majority minority school systems at the center of the region's minority population base.

At all levels of the school systems, from superintendents and administrators, through faculty, to students, people are enthusiastic and committed to the Center's goals and programs. Issues of turf, control, and other conflicts have not surfaced or have been overcome in what may be the prospective Center's greatest single accomplishment: to act as a catalyst for cooperation and growth in all the institutions and organizations in the

consortium.

Biotechnology Process Engineering Center at MIT

Some of the consortium participants are represented by key individuals rather than the institution as a whole. In the case of MIT, Dr. Daniel I.C. Wang of the Biotechnology Process Engineering Center will contribute the support of his organization in activities from pre-college student participation in lab work, to lending faculty to summer institutes, to faculty interaction with high school teachers, to high school summer internship programs for teachers at MIT.

Educational Technology Center at Harvard Graduate School of Education

Co-directors Judah Schwartz and Martha Stone Wiske of ETC contribute to the pre-college student community in mathematics and science with their metacourses and prototype software in areas and problems that are "targets of difficulty," topics that are central to mastering a field but are notoriously difficult to learn. ETC will lead the work with teachers to improve their mastery of science, mathematics, and contemporary technology. The ETC staff and the extended programs they coordinate will work on issues of subject knowledge, pedagogic knowledge, and staff development knowledge through projects like the Advisor Teacher Program.

The Algebra Project

Robert Moses, Director of the Algebra Project, will bring his program for teaching algebra to all middle school students in the Boston and Cambridge public schools. The Algebra Project prepares teachers to teach algebra in a construction rather than transmission mode, and prepares middle school students to take pre-college mathematics courses in high school.

The Cambridge Partnership for Public Education

Alan Dyson, Executive Director of the Cambridge Partnership, brings together Cambridge public school teachers, industrial scientists, and college teachers. The Partnership works with linkages including Lesley College, a Cambridge college with a strong teacher training program, and Polaroid's

Project Bridge, which encourages Polaroid scientists to consider teaching as a career and brings Cambridge teachers into the Polaroid labs for a year before they return to teaching. Beyond the Cambridge Partnership's brokering between public schools and the private sector lies continuing work to bring resources and expertise into the Cambridge public schools and to implement collaborative educational programs answering focused needs.

Industry in New England

Northeastern's Co-op Program, ongoing support for Pre-NUPRIME and NUPRIME, and mentoring programs like those of the Boston Compact, represent the existing involvement between industry and Boston area schools in science, mathematics, and engineering. The new Center programs, like Parallel Co-op and the Visiting Scientist Program, will tighten the relationship between students all along the educational pipeline and industry eager for well-prepared people to draw into the workforce.

The historic strength and reach of Northeastern's Co-op Program is at the heart of the integration of industry involvement in the Center. That involvement is clearly important to the success of several program elements involving career information, industry resources, and links between academic experience and the workplace. Ultimately more important, however, is that the existing links between Northeastern, the home institution of the Center, and industry overcomes a major barrier to continuing programs beyond the funding period--on-going financial support.

Industry in New England is a deeply interested party in the Center's achievement of its goals, as statements of the problems throughout this proposal demonstrate. Northeastern University is committed to the on-going existence of the Center. That combination of interest and commitment is the foundation for assurance that Center programs will be perpetuated beyond NSF funding.

## VI. Evaluation, Program Monitoring, Participant Monitoring

The Center begins with the advantage that the institutions and organizations participating in its programs are experienced in recordkeeping for their projects and in monitoring their target populations. With the Urban Science Academy as a central clearinghouse for programs and for coordinated approaches to participants and target populations, information will be centralized and consistent.

The Center will use its monitoring and evaluating procedures to go beyond the foci of its programs and give larger coordinated information about potential approaches to increase the Center's reach and retention. Participant information, for example, may suggest programs for siblings who can be reached at an early age. Demographic information may suggest outreach and recruiting programs for recent minority immigrant groups.

## Program Component Monitoring

The Center's monitoring and evaluation system will be based on milestone reviews, which in turn will be determined by the primary components and issues related to the larger program plan. The phase review concept--evaluating schedules, resources, and the technical status of the milestones chosen--will underpin the program monitoring.

Using each program's funding level and their experience with previous program development, program coordinators will develop concrete program plans and milestones, which will be reviewed by the Project Director and his staff. The project staff will meet semi-monthly to coordinate project operation. Quarterly reports to the Project Director and quarterly project review meetings will be required in which deviations from program plans or budgets will be raised and justified, as appropriate. Significant deviations will require modifications to the written program plan and the Project Director's approval.

## Program Component Evaluation

The Center will follow NSF policies and guidelines pertaining to

schedules, resources, activities, and reports. The Center's primary point of focus in evaluating program components is the goal of increasing the pool of underrepresented minorities in mathematics, science, engineering, and technology. Thus the measures of success will be related to

- the number of program participants and, where pertinent, their retention rate
- the attitudinal, motivational, and academic enhancement the programs provide
- the number of participants who who complete education programs leading to careers in mathematics and science.

Most of the measures address students in all grades--but because significant attention is addressed to improving the quality of science and mathematics teaching and links between students, teachers, and community programs--attitudinal, motivational, and academic enhancement criteria pertain to teachers, counselors, and community members as well.

The Center will maintain a computerized database for each participant in a program or project, regardless of point of entry. Student databases will track the students longitudinally to measure the long-term impact of programs on this target population. Information may be used more creatively or actively to invite further involvement by students. Other records will be kept as indicators of the scope of reach of programs in the community.

K-12 The Urban Science Academy

For the lower grades, the focus on program evaluation will include measures of change in attitude, career knowledge, and academic preparation in mathematics and science. Participants in each activity will respond to pre- and post-activity assessment instruments, the results of which will be recorded in student and program databases to help measure the impact of the program.

Teachers in the powerful programs for enhancing pre-college education in mathematics and science will receive training emphasizing teaching techniques and mathematics and science content consistent with National Council of Teachers of Math4ematics (NCTM) and National Science Teachers'

Association (NSTA) standards. Program success will be measured by the extent to which teachers incorporated content and experience from the programs in their classes and laboratories. Course grades, follow-up questionnaires, and program ratings by teacher participants will be incorporated in the program evaluation database.

**High school students'** assessments will cover a range of categories:

- career awareness
- attitudinal changes
- changes in mathematics and science scores on standardized tests
- changes in academic performance in mathematics and science
- levels of enrollment in pre-college mathematics and science courses
- changes in laboratory skills.

Longitudinal evaluation will monitor high school course selections, college enrollment, choice of college major, and entry into graduate study programs or the workforce.

**Undergraduate** programs will be evaluated by their success in enriching the academic preparation of the student in the target population; retaining students in their programs of study; and increasing the numbers of students who earn undergraduate degrees and those who enter and complete graduate degree programs. Success will be measured by students' academic performances and attrition rates in comparison with cohorts of non-participants. Articulation between institutions, primarily community colleges and universities, will be evaluated on the basis of the percentage of institutions brought into articulation agreements and the percentage of potential mathematics, science, or engineering majors who participate in the articulation program.

**Community programs** will be evaluated on the reach of the program--number of institutions using the program and size of audience.

## Computer Tracking System

The databases will be programmed in dBase IV, a full-featured database

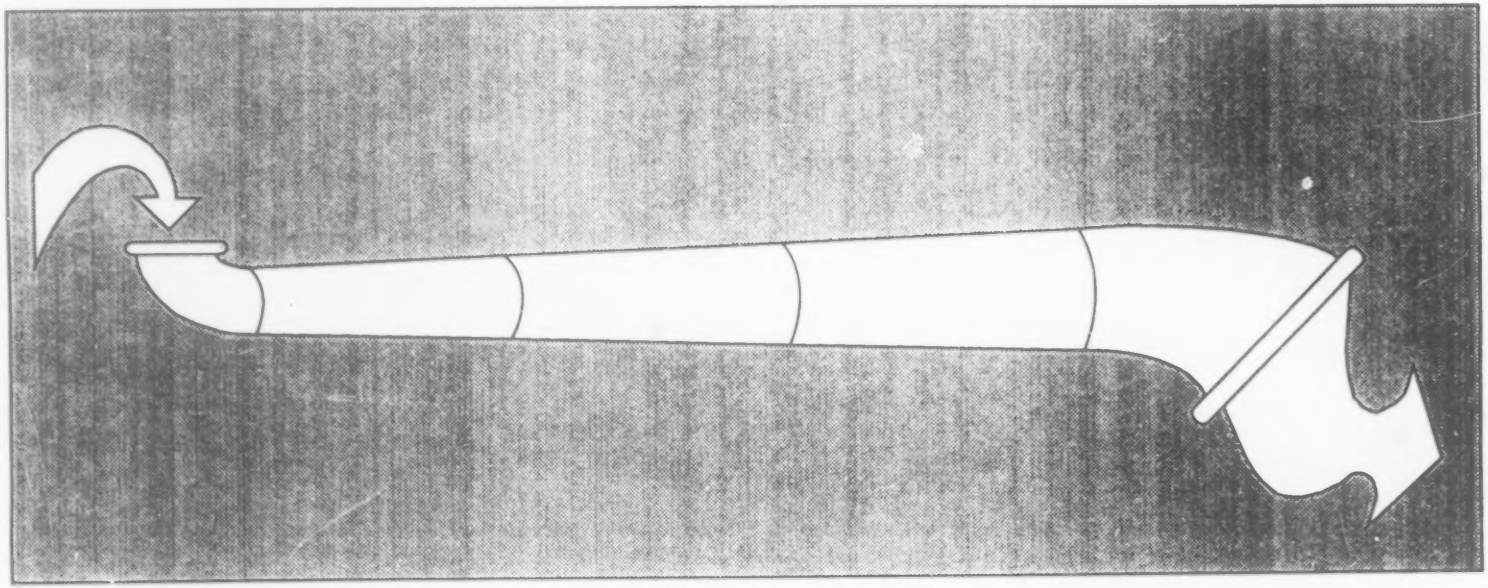
management system, on IBM-PC compatible computers. The databases will be designed to be user friendly and error tolerant so that data can be entered and manipulated easily by secretarial help. Using this well known and commonly available database system will facilitate electronic transfer of program activity information. dBase IV's strong report generating capabilities will be called upon for reporting activities.

## Project Continuation

The Univeristy has committed itself to continuing the activities of hte Regional Center after NSF funding ceases. Its commitment will be at esentially the same level as during the final year of Foundation support.

Additional funds will be sought through a vigorous development campaign designed to raise money for such Center programs as the Urban Science Academy, the Outreach Program in Biotechnology, and programs by various acaemic departments. This development effort will commence at the beginning of year one and will paritcularly involve the Project Director and the Chairman and members of the Governing Board who have been selected with an eye towards this aspect of thier duties. The new graduate assistantships in science and engineering departments will be funded by a variety of emans: tutition waivers, University fellowships, and corporate sponsorships. The Visiting Scientists program will be continued if regional universities benefiting from the program will agree to contribute toward its cost.

## Solutions: Pumping Minority Students Through the Pipeline



**Elementary School**
- Urban Science Academy After-School Program
- The Algebra Project
- Metropolitan Boston Museum Programs
- Teacher Advisor Program

**Middle & High School**
- Urban Science Academy Summer Program
- Pre-NUPRIME
- Biotechnology Special Institute
- Visiting Scientists Program
- MassPEP
- Thirteenth Year
- What is Engineering?

**2-Year & 4-Year Colleges**
- NUPRIME
- Project Interlock
- Expanded Co-op Programs
- Network Northeastern

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